SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1920.

GENERAL PHYSICS.

1114. *New Instrument for Measuring Sky Radiation.* **A. Ångström.** (Monthly Weather Rev. 47. pp. 795–797, Nov., 1919.)—This instrument for measuring the intensity of diffused daylight is based on the principle of electrical compensation. The radiation falls on white and black metal strips having at the back thermoelectric junctions, and the temperature equilibrium, disturbed by the unequal absorption of the strips, is restored by passing an electric current (i) through the white strips. Then if R is the intensity of the radiation, $R = ci^2$, where c is the constant of the instrument. Direct sunlight is cut off by a circular screen of diam. about 5 cm. placed 40 cm. from the strips. Two features are noteworthy. (1) The white strips are coated firstly with platinum black, like the others, and then with magnesium oxide. The absorption of the white strips, as also that of the black strips, is then practically independent of the wave-length for sky radiation. (2) Dark radiation is excluded from influencing the instrument in a two-fold way, (*a*) because the magnesium oxide and platinum black absorb almost equally for these wave-lengths, (*b*) a glass cover over the strips cuts out long-wave radiation.

The constant c has been determined and is 8·42 when i is in amps. and R in gm. cals per cm.^{2} per min. Comparisons with other instruments show satisfactory agreement. M. A. G.

1115. *Simple Substitute for the Cathetometer.* **J. B. Ferguson.** (Washington Acad. Sci., J. 10. pp. 285–286, May 19, 1920.)—Describes the use of a "micrometer depth gauge" to replace a cathetometer in pressure readings. The gauge usually consists of a vertical rod with a sliding head mounted perpendicular to the rod and provided with a micrometer or a vernier. The head has a polished surface about 13 mm. wide, which is sufficient to enable one to make an accurate setting by sighting across it against a mercury meniscus. Five observers tested were found capable of measuring a pressure difference to about ± 0·02 mm. T. H.

1116. *Measurement of Small Time Intervals, and Ballistic Applications.* **L. T. E. Thompson, C. N. Hickman,** and **N. Riffolt.** (Nat. Acad. Sci., Proc. 6. pp. 169–178, April, 1920.)—Precision in time calibration is of importance in many classes of research. Several types of apparatus have been developed for this purpose. With any apparatus involving a rotating drum, it is necessary to maintain the speed of the motor driving it within certain limits and to secure a dependable calibration, usually placed on the record as it is being made. A tuning-fork producing a photographic or mechanically-inscribed record of a sinuous form, is perhaps the commonest example of calibrating device. A very successful alternative method was recently developed at the Bureau of Standards by Duncan and Cortis, in which straight lines were produced across the photographic film by the interruption of light passing through slits attached to the tuning-fork. A new fork has been constructed giving about 2000 lines per sec. It is considered that this could be increased to 10,000 or 12,000 lines per sec.

Most of the methods at present used in ballistics for the measurement of velocity involve the passage of the projectile through screens of one sort or another, breaking or making electrical circuits. The method devised by the present authors does not require that any material be touched by the projectile in its flight, but simply the passage twice through a beam of light. It is found that it is only necessary to observe the flight of the projectile over a space of from three to five feet, since absolute determinations of time intervals as small as a millionth of a second are possible. E. H. B.

1117. *Resistance of Ductile Materials to Combined Stresses.* **H. M. Westergaard.** (Frank. Inst., J. 189. pp. 627–640, May, 1920.)—Describes the principal theories which have been proposed for the determination of the strength of a material subjected to two or three stresses in mutually perpendicular directions. If the material is isotropic, the absolute directions of the principal stresses are immaterial, and the stress at any point can be graphically represented by rectangular coordinates of a plane diagram in the case of two stresses, and of a three-dimensional diagram in the case of three mutually perpendicular stresses. Each possible state of stress then defines a point on this diagram, and the condition of resistance to compound stress may be stated by requiring the stress point to be within, or on the surface of a certain solid. The surface of the solid determines the limiting stresses, and therefore the problem of resistance to combined stresses may be stated as the problem of determining this solid. The maximum stress theory, of course, gives a cube for this solid, the max. strain theory a skew parallelepiped. The max. shear theory gives a regular hexagonal prism, and the combination of max. shear and max. strain theory gives a twelve-faced polyhedron, which is described, and of which a model is illustrated in the paper. In a final note it is stated that the experimental results quoted by Haigh [see Abs. 488 (1920)] agree equally well with the maximum shear and maximum strain theory as with the maximum resilience theory.
J. W. T. W.

1118. *Steels of Zero Thermo-Elastic Coefficient.* **C. E. Guillaume.** (Comptes Rendus, 171. pp. 83–87, July 12, 1920.)—The similarity between the thermal coefficients of expansion and of elasticity of nickel steels led the author to experiment with a nickel steel containing a proportion of chromium for the attainment of a zero thermo-elastic coefficient without great sensitivity to the exact proportion of nickel present. A steel found to give excellent results was one containing about 36% Ni and

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12% Cr (or its equivalent when combined with small quantities of Mn, W, or C). A watch containing a spring of this alloy, with a single metal balance, was found to have a practically linear rate variation with temperature. With a spring of this alloy, therefore, it is only necessary for the balance to compensate for the expansion of the spring, and not for its change of elasticity as well. J. W. T. W.

1119. *Ballistics of Seventy-five Mile Range Gun.* **A. G. Webster.** (Am. Phil Soc., Proc. 58. No. 6. pp. 373–381, 1919.)—The paper gives the calculations of an attempt to arrive at the general character of the trajectory of the long-range shells fired by the Germans into Paris prior to any details being obtained of the size and shape of the projectile.
G. W. DE T.

1120. *A Method in Ballistics.* **A. G. Webster** and **M. Allen.** (Am. Phil. Soc., Proc. 58. No. 6. pp. 382–385, 1919.)—The author here reproduces a description, published in the Physical Review 6, 1898, of a time-measuring instrument consisting essentially of a projectile dropped from an electromagnet upon two levers, one of which is borne by a carriage adjustable by means of a micrometer screw, the time being given by the length of fall. A battery charges a condenser through a resistance, the condenser being short-circuited through a conductor, which in the calibration is the fixed lever of the drop interruptor. When the circuit is broken the condenser begins to charge in accordance with the equation $q = q_0(1 - \epsilon^{-t/KR})$. The calibration curve shows that times may be measured of the order of 10^{-6} sec. Two strips of tinfoil shot away by the projectile start and stop the charging. It is possible to measure the velocity of a projectile when the strips are an inch apart, but a distance of 2 to 3 ft. is usually taken, which may be contrasted with the 100 to 150 ft. generally used in ballistic laboratories of arms companies.
G. W. DE T.

1121. *Viscosities and Compressibilities of Liquids at High Pressures.* **J. H. Hyde.** (Roy. Soc., Proc. 97. pp. 240–259, May 1, 1920.)—This research was undertaken for the Committee on Lubricants and Lubrication of the Department of Scientific and Industrial Research, for the purpose of the analysis of the results of a previous investigation into the efficiency of power transmission through a worm gear when different kinds of oil—animal, vegetable and mineral—were used as the lubricant. Since pressures of the order of 5 tons per sq. in. between the lubricated surfaces of worm gears are not uncommon, a knowledge of the rates of variation of the viscosities of the oils up to these pressures was essential A direct measure of the changes of viscosity of the oils under pressure did not seem promising, so that the experimental work was divided into 2 stages :—(1) The values of the kinematical viscosity η/ρ were determined ; (2) apparatus was devised after investigation (1) was completed, for the study of the changes of density with pressure. Part I of the paper describes the apparatus for the determination of the absolute kinematical viscosities of liquids at high pressures and the results obtained from it in the case of certain lubricating oils. The oils tested were good commercial samples of their kind, the vegetable oils being represented by castor and rape, the animal by " trotter " (a substitute for lard oil), the fish by sperm, and the mineral by F.F.F. Cylinder, Victory Red, Bayonne, Mobiloil " A," and Mobiloil " BB." Tables of results are given with 3 sets of curves. The viscosity of water was determined as a check on the accuracy of the instrument.

Part II deals with a special apparatus devised by the author for the determination of the compressibility of liquids, and gives the values obtained for water and the above lubricating oils. The curves show that the viscosity increases with pressure, and at an increasing rate as the pressure rises. Extreme care in the measurement of the pressure had to be taken, especially in the cases of the mineral oils, in which, at pressures above 800 kg. per cm.^{2}, the rate of change of viscosity with pressure is very great. The curves show a difference between the fixed and the mineral oils. The latter vary considerably among themselves, and generally have a high rate of increase of viscosity with pressure. The fixed oils, however, do not greatly differ from each other, and show an increase in viscosity at 1000 kg. per cm.^{2} to approximately four times their values at atmospheric pressure, compared with anything between 10 and 25 times the corresponding values for the mineral oils. H. H. Ho.

1122. *Mass, Energy, and Radiation.* **J. J. Thomson.** (Phil. Mag. 39. pp. 679–689, June, 1920.)—The author develops a new method of representing physical processes in terms of physical conceptions. From the electrical viewpoint the mass of an electron is distributed throughout the surrounding region; and if at rest, the mass per unit volume at any point is proportional to the squared electric force at the point. So is the electrostatic potential energy per unit volume at the point, and is therefore proportional to the mass. But the former is equal to the kinetic energy which the mass would possess if moving with the speed of light, suggesting that the potential energy in the electrostatic field is really the kinetic energy of the distributed mass regarded as an aggregate of equal particles moving with the speed of light. In a stationary field they may be supposed to revolve with this speed round the lines of electric force. Generalising this, suppose all mass distributed through space with density determined by the electric field at the place where the mass is supposed located, and energy of every kind to be of one type—the kinetic energy of these mass particles. Then every so-called energy transformation will be simply a flow of the mass particles in space, and gain of energy by a body will be regarded as due only to increase in its mass. The process is set out in detail for the case of a moving electron, and it is pointed out that the kinetic energy of an isolated system will, if action and reaction are equal and opposite, be independent of the reference frame, so that, on the method here considered, the energy associated with an electron, for example, could be so determined if there existed any physical means of comparing the number of mass particles in one region with that in another. But no such method being known, an observer in a system A, set in motion as a rigid body by the action of an external system B, would be unable to detect the change to the new rate of translation ultimately imposed on A; for though the mass of one of the constituents, as measured by the number of mass particles associated with it, may be altered, the mass of the unit by which that of the constituents is measured will be altered in the same proportion. The existence of such particles being assumed, it is shown that at least 10^{10}, and probably many more, will be required to supply the mass of an electron. Since they move with the speed of light, they will on the Lorentzian transformation retain this speed for any reference frame. In addition to the mass particles we must assume the existence of lines of electric force spreading through space and determining the distribution and movement of the particles. The lines may be closed or may begin and end at definite points in an electron and a positive unit of electricity respectively. The connection between the distribution of the mass particles and the lines of force is given by the rule that the mass per unit volume at a point P is proportional to $f^2 + g^2 + h^2 + (\alpha^2 + \beta^2 + \gamma^2)/c^2$, f, g, h being the number of lines of force passing through a unit area at P perpendicular to the axes of x, y, z respectively, α, β, γ the components of magnetic force, and c the speed of light. Magnetic force is regarded as due to the motion of the lines of electric force past the observer who is measuring the former. Then the relations between electric and magnetic force and the components of the momentum per unit volume at P will be of the usual forms, and, by Hamilton's principle, the Maxwell stresses which reproduce the mechanical forces in the electric and magnetic fields can be deduced from the expression for the energy. The mass particles perform the functions both of ether and matter—of the latter by endowing the electrons and + charges in the atoms of the chemical elements with mass, and of the former when moving through space and carrying energy with the speed of light. But lines of electric force form also an integral part of ether and matter. We have matter only when lines of electric force end in electric charges, radiation only when we have along with the mass particles closed lines of electric force. In a steady electrostatic field the mass particles are constrained to closed paths round the lines of electric force, causing tension in the latter, which being anchored in electric charges, carry with them the charges and the masses condensed about them. In a changing electric field, either by motion of the charges or otherwise, the lines of electric force may become looped, and some of them may form closed curves which being unanchored may be dragged away with the mass particles moving with the speed of light, thus giving rise to radiation, which therefore, on this view, involves mass transference proportional to energy transference. When a light wave traverses a refracting medium the electrons therein are set vibrating and give out secondary waves, the effect of which is to make the apparent velocity of the light through the medium depend on the number of electrons therein. A detailed analytical investigation is to follow in another paper. Since the speed of the mass particles is invariable, that of light will be unaffected by motion of the source, or when reflected, by the rotation speed of the mirror. Recent experiments by Majorana are in accordance with this. The dynamics of processes involving very small energy transferences will obviously be those of a quantum theory, and in view of energy being indivisible below a certain limit, the inverse square law of electrical attraction cannot hold at all distances. G. W. DE T.

1123. *Representation and Measurement of Time.* **E. Guillaume.** (Archives des Sciences, 2. pp. 125–146, March–April, 1920.)—This is a continuation of the general argument of the author's former paper [Abs. 382 (1919)] in which, as he here expresses it, he sought to substitute analytically, in relativity theory, a monoparametric for a polyparametric representation of time. In the present paper he assumes the Kantian view of time as a unique entity, taking as his starting point Kant's statement that different times cannot be simultaneous, assuming with him that this statement is a "synthetic *a priori* judgment," and therefore an apodictic certainty. He introduces from the first the travelling clock, which is supposed to measure the time-like coordinate x_4 [and which Larmor has characterised as the main source of confusion in relativistic discussions]. The author's final conclusion is that the monoparametric and polyparametric representations are equivalent. G. W. DE T.

1124. *Quaternion Treatment of Relativistic Dynamics.* **H. T. Flint.** (Phil. Mag. 39. pp. 439–449, April, 1920.)—L. Silberstein has shown [Abs. 1155 (1912)] that if q and q' be quaternion forms of a Minkowski form-vector, referred to frames S and S′ relatively in uniform motion of translation, then q' can be derived from q by the fore and aft application to the latter of a certain quaternion operator Q, so that the quaternion equation $q' = Q[q]Q$ is equivalent to the Lorentz transformation. Any quaternion which can be transformed in this way is called by Silberstein a physical quaternion. The author applies this method to the treatment of velocity, force, and momentum, obtains some quite general transformations in the case of electric and magnetic forces, and obtains a solution of the problem of the field due to a uniformly moving charge by a very simple application of the general formulæ. G. W. DE T.

1125. *Central Equation of Einstein's Theory.* **A. R. Forsyth.** (Roy. Soc., Proc. 97. pp. 145–151, April 1, 1920.)—The equation $(du/d\phi)^2 + u^2 = (c^2 - 1)/h^2 + 2mu/h^2 + 2mu^3$, where m is the sun's mass, u the reciprocal of the distance of the moving body from the sun, $h^2 = ma(1 - e^2)$, $c^2 - 1 = - m/a$, a having the major semi-axis of the orbit, the units being astronomical, and e is the eccentricity of the orbit [Eddington, Relativity Theory of Gravitation, 2nd edition, p. 50], is the critical equation of Einstein's relativity gravitation theory. The author shows it to be exactly integrable in terms of elliptic functions, and that the approximations for the solar system are easily obtained since the modulus of the functions is small. The necessary analysis is given in the paper. G. W. DE T.

1126. *Possibility of Purely Electromagnetic Atoms in a Modified Einstein Gravitation Theory.* **T. De Donder** and **H. Vanderlinden.** (Comptes Rendus, 170. pp. 1107–1109, May 10, 1920.)—The authors have succeeded, while conserving Hamilton's principle as generalised by Lorentz, in modifying Einstein's system of equations in such manner that the generalised force is not everywhere zero, in which case no purely electromagnetic atom would be possible. The generalised force in the modified system is given by $F_i = d\Gamma/dx_i (i = 1, 2, 3, 4)$, where $\equiv (kC + 2a)\sqrt{-g}$, and in general differs from zero; and k and a are universal constants and C is the total curvature. G. W. DE T.

1127. *Equilibrium Figures of Rotating Liquid.* **A. Véronnet.** (Comptes Rendus, 170. pp. 1303–1305, May 31, 1920.)—The author first calls attention to a very simple demonstration by P. Appell, in a work now in the press, of Poincaré's theorem, that the first ellipsoid of bifurcation in the series of Maclaurin ellipsoids (ellipsoids of revolution) is the one which gives rise to the Jacobi series of ellipsoids with three unequal axes. He then briefly outlines a generalisation of Appell's method applicable to other bifurcation figures and to the determination of the order of their appearance in the Maclaurin and the Jacobi series. G. W. DE T.

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1128. *Accelerated Motion of a Spherical Body in a Resisting Medium.* **F. S. Schmidt.** (Ann. d. Physik, 61. 7. pp. 633–664, April 15, 1920. Dissertation, Leipsig.)—The motion of wax spheres falling in water and pilot-balloons rising in air from rest until the terminal velocity is reached, is studied experimentally by a photographic method, which records on a plate the position of the body at equal intervals of time. By measuring the plates, the variations of velocity during the accelerated motion of the body are obtained. Bodies of various sizes and masses were used in the experiments, and the results transformed to apply to a standard sphere falling in water at temperature 18° C., by the law of similarity of fluid motion, confirmation of which is obtained. It is found that, after the terminal velocity (v_{E}) is attained, the resistance (wg) is given by $wg = \psi\rho \mathrm{F} v_e^2$, where ρ is the density of the fluid, F the cross-section of the body, and $\psi = 0 \cdot 22$, provided that $600 < \mathrm{R} = v_e r/\nu < 1500$, where R is Reynolds' number, r the radius of the sphere, and ν the kinematic viscosity of the fluid. Before the velocity (v) reaches the terminal velocity, $wg > \psi\rho \mathrm{F} v_e^2$, and approximately $wg = \psi\rho \mathrm{F} v^2 + b_1 dv/dt + b_2(dv/dt)^2$, while $v = v_e(1 - c^t)$, where c is a constant < 1. The velocity does not, however, increase steadily with the time before reaching the terminal velocity, but owing to the formation of a vortex ring behind the sphere, first attains a maximum and then a minimum value, and proceeds to oscillate while approaching the final value. There is a simple relation between the value and time of occurrence of the first maximum, and also of the first minimum. Utilising results of other investigators, the range for R above may be extended, and the results of this paper used, in conjunction with the law of similarity, to predict the motion of any sphere rising or falling under any force in any fluid, provided $600 < \mathrm{R} < 50{,}000$, where R corresponds to the terminal velocity. M. A. G.

1129. *General Kinetics of Material Transformations.* **A. J. Lotka.** (Am. Acad., Proc. 55. pp. 137–153, March, 1920.)—A general discussion of the differential equations of chemical dynamics has been given by J. Jüttner [Zeits. Phys. Chem. 77. p. 35, 1911], in so far as they apply to a single chemical reaction taking place in accordance with the law of mass action. The present treatment is more general, independent of the law of mass action, and covering a wider field of concurrent reactions of various types. The equations of a physical system undergoing change of state are of the general form $\mathrm{X}_k = \mathrm{F}_1(\mathrm{X}_1, \mathrm{X}_2 \ldots \mathrm{X}_n; \mathrm{P}_1, \mathrm{P}_2 \ldots \mathrm{P}_j)$, where $k = 1, 2 \ldots n$, the X's are the masses of the components of the system, and the P's measure certain parameters defining the state of the system, such as pressure, temperature, etc. The sole assumption in the present paper is that the functions F are analytical in the neighbourhood of the equilibrium values of the variables X. A general solution is obtained for the case that the parameters P are held constant during the transformation. This solution is oscillatory or aperiodic, according as the roots of a certain determinantal equation are complex or real. The effect of equations of constraint is discussed. Convergence of the series solution is shown to be related to the stability of the system at the equilibrium point. Several special cases are considered:—(1) Single transformation, the commonest example of which is one simple chemical reaction, reversible or not, unaccompanied by any simultaneous reaction: Consecutive transformations. The well-known property of chains of radio-active transformations, that the products are present in constant ratio, is shown to be quite general for the terminal stages of any series of consecutive reactions, whatever their laws, provided only that the functions F are analytical as assumed above. A similar conclusion applies to all systems in which the process of transformation is aperiodic. In general, in a complicated system, the process is oscillatory. The entire development set forth presents an analogy to Lagrange's theory of small oscillations. But here, instead of $2n$ arbitrary constants, corresponding to n coordinates, there are n constants only. This results from the systems considered being essentially inertia-free or completely damped, in which velocities are completely determined when the values of the generalised coordinates are given, and in which the accelerations vanish with the velocities. They are accordingly typically reversible processes, typical cases of evolution. Indeed, the author's objective has been to pave the way for a general investigation of the dynamics of evolution. The X's may be masses of any species of material complexes in any mutual relation of interdependence, *e.g.*, they may be the masses of biological species dependent on each other for food and in other ways. The equations developed by Ronald Ross [Nature, p. 466, Oct. 5, 1911, A. J. Lotka, *ibid.*, p. 497, Feb. 8, 1912], relative to the interdependence of the malaria parasite, the anopheles mosquito, and man, fall within the type here considered, and their solution is comprehended in the general solution given here. G. W. DE T.

1130. *Size of Atoms.* **A. Landé.** (Zeits. f. Physik, 1. 3. pp. 191–197, 1920.)—Observations on the size of atoms in the combinations of the alkali metals and rare earths with the halogens. The grating constants, $\delta \times 10^8$, for these substances are given in the following table:—

LiF	4·00	LiCl	5·11	LiBr	5·45	LiI	5·95
NaF	4·60	NaCl	5·59	NaBr	5·98	NaI	6·47
KF	5·31	KCl	6·24	KBr	6·59	KI	7·05
—	—	RbCl	6·57	RbBr	6·88	RbI	7·33
—	—	CsCl	6·53	CsBr	6·81	CsI	7·23

Using these data the author obtains the values of the sum of the atomic radii of the elements in combination. A. B. W.

1131. *Crystal-gratings.* **A. Reis.** (Zeits. f. Physik, 1. 3. pp. 204–220, 1920.)—The author discusses the possible bearing which a complete knowledge of crystal structure, as revealed by X-ray analysis, may have in relation to numerous other allied problems, both chemical and physical. With this object in view a purely geometrical view of crystalline space-lattices is taken, and applied in the following cases:—(1) Problems of chemical combination. (2) Crystallographic phenomena. (3) Molecular and ionic structure of matter. (4) Relations between chemical constitutions and forces of cohesion. The study of compressibility, hardness, and thermal expansion of substances. Cohesion in solids (crystalline and amorphous) and in liquids. (5) Optical properties of chemical combinations. (6) Polymorphic modifications. (7) Ion-gratings. (8) Models of gas-molecules and crystal space-lattices. A. B. W.

1132. *Empirical Laws of Variation of Pressure and Density with Height.* **R. Soreau.** (Comptes Rendus, 169. pp. 1023–1025, Dec. 1, 1919.)—A series of observations by "ballons-sondes" is taken, and each ascent is adjusted to a sea-level pressure of 760 mm. The formula $z = 5(3064 + 1{\cdot}73P - 0{\cdot}0011P^2) \log (760/P)$ is found to represent the height (z) in terms of the mean pressure (P) very closely between 2 km. and 17 km., and probably up to 23 km., while the mean density (a) is given in terms of P by $\lambda/\mu = 3744/\{3064 + 1315\mu - 635\mu^2 + (3028 - 2924\mu)\mu \log \mu\}$, where $\lambda = a/a_0$ and $\mu = P/760$. Up to 10 km. $\lambda = 0{\cdot}4(3{\cdot}6 - 2{\cdot}1\mu + \mu^2)$ is a sufficient approximation These formulæ would find an application in technical aeronautics, *e.g.*, as regards pressure, in the rate of ascent, and density, in the action of the propeller and feeding of the engines The formula for density shows that λ decreases less rapidly than μ, which is said to be less unfavourable for the feeding of the engines than the inexact relation $\lambda = \mu$. M. A. G.

1133. *Comparisons between Pyrheliometers and the Difference between the Ångström Standard and the Smithsonian Standard.* **A. Ångström.** (Monthly Weather Rev. 47. pp. 798–799, Nov., 1919.)—In 1912 the Ångström Standard (A.S.) was compared with the Smithsonian Standard (S.I.S.) by comparing each with the Ångström pyrheliometer No. 158, with the result: S.I.S./A.S. = 1·0327. A further comparison in 1919 yielded S.I.S./A.S. = 1·0323, a remarkably good agreement, the difference being much less than the probable error. A comparison by Marten at Potsdam is also in good agreement with this. A conclusion is reached that neither standard has been subjected to any important change since 1912. The author holds that 1·8% of the difference may be due to special features in the construction of the electrical compensation pyrheliometer, but the remaining 1·5% adheres to the Smithsonian scale. M. A. G.

1134. *Some Problems relating to the Scattered Radiation from the Sky.* **A. Ångström.** (Monthly Weather Rev. 47. pp. 797–798, Nov., 1919.)—Emphasis is laid on the importance of the contribution of diffuse sky radiation to the total income of heat by radiation, and co-operation in the study of this subject is urged. From observations at present available it appears that for high sun, clear sky, and medium diffusing power it is about 20% of the solar radiation, the percentage increasing with increasing zenith distance of the sun and increasing cloudiness. A table, based on the average of a few cases, shows that as the cloud sheet increases in density the actual sky radiation increases to a maximum, and then decreases again, finally reaching, with very dense Nb, approximately the value for a cloudless sky. The maximum occurs with a cloud sheet equivalent to not very dense St-Cu, and it is at this point that direct sun radiation is practically nil. When the sky radiation has decreased to a certain value, owing to increasing density of the cloud sheet, rain usually begins to fall, and for uniformly clouded sky and constant solar height this actinometric rain limit appears fairly constant, a result of possible use in forecasting. M. A. G.

1135. *Improved Form of Snow Sampler.* **B. C. Kadel.** (Monthly Weather Rev. 47. p. 697, Oct., 1919.)—This instrument is not new in principle, but includes many improvements in detail as a result of the writer's practical experience in snow surveying, *i.e.*, deducing the water equivalent of a snow layer over a wide area by weighing sample sections, avoiding snow drifts. There are three main parts: (1) The main tube to hold the sample; (2) an attachment at one end with a circular cutting edge to cut the snow as the tube is pushed down into it, and to limit the area of the section; (3) the spring balance to weigh the whole when withdrawn. The main tube is of 3-in. drawn-steel tubing all in one piece, and only practically useful up to 6 ft. in length. Longitudinal slots in the wall facilitate the clearing out of the snow, while the tube is finished by sherardising (similar to galvanising), thus leaving a smooth finish and helping the snow core to slide freely; oil or lacquer applied to the inner surface also helps in this respect. The cutter has an inside diam. of 2·655 in., making $\frac{1}{5}$ lb. of snow equivalent to one inch of water. This diameter is the result of a number of careful experiments, and is somewhat smaller than that of the main tube. The cutter is sharply shouldered off inside to help the withdrawal of the core with the tube. The spring balance reads water equivalent direct, and is made of aluminium.

M. A. G.

1136. *Formula for Relation of Mean Wind Velocity to Altitude with respect to Hellmann's Investigations.* **F. Bradtke.** (Meteorolog. Zeits. 35. pp. 313–315, Nov.–Dec., 1918. Monthly Weather Rev. 47. p. 707, Oct., 1919. Abstract.)—Hellmann has given two formulæ for the mean wind speed at various elevations, (1) $v = a + b \log (h + c)$ for $h > 123$ m. and (2) $v/v_0 = \sqrt[5]{h/h_0}$ for $h < 16$ m. He implies that there is no simple expression applicable to all altitudes. The present writer, however, proposes the formula $v = 1{\cdot}2 + 1{\cdot}79\, h^{0{\cdot}246}$ for the speed at any elevation, and supports it by comparison with observations at various heights up to 500 m. made at Nauen, Lindenberg, and on the Eiffel Tower.

M. A. G.

1137. *Propagation of Cold Air on the Surface of the Earth.* **F. M. v. Exner.** (Akad. Wiss. Wien, Ber. 127. 2a. pp. 795–847, 1918.)—The general problem for solution is: Given a mass of dense air of known form and state of motion, covering a small region of the earth's surface, and bounded above and around by less dense air also in known state of motion, to determine the subsequent movement and changes of form of the dense air. The problem is solved for some particular cases in two dimensions, by the hydrodynamical methods applicable to waves at the surface between two fluids of unequal density, but the results sought are mainly qualitative. The dense air is taken initially in the form of a ridge of rectangular cross-section and infinite length. If both fluids are originally at rest, and friction and the earth's rotation are neglected, then the ridge breaks up into two of equal breadth and half the height of the original, travelling in opposite directions perpendicular to their length with a velocity proportional to the square root of the difference of absolute temperature between the cold and warm air. As the ridges move apart the warm air flows in and covers the region of the earth's surface between them. Introducing friction, the ridges separate as before, but decrease in height as they advance, the space between them remaining covered with cold air. In this case, too, the rear of each advancing ridge is higher than the front. On a rotating earth without friction the cold ridge, supposed streaming in the direction

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of its length, breaks up as before, but the ridge travelling to the left of the direction of streaming (N. hemisphere) increases in height, while the other decreases. The velocity of propagation is now greater than before, and the front of each ridge higher than the rear. If the warm air above is streaming at right angles to the ridges, it has the effect of checking the advance of one of them, and may, if strong enough, reverse its motion and make it slowly follow the other, which has its velocity of propagation increased. Other cases are obtained as combinations of these. A comparison is made with observations on the spreading of cold waves over Europe and N. America. The author finds in this work an explanation of the phenomena exhibited on these occasions, and in particular of the observed fact that when cold air breaks through from the Polar regions it first seeks to spread W. or S.W., then S., S.E., E., and often finally N.E. M. A. G.

1138. *Variations in the Total and Luminous Solar Radiation with Geographical Position in the United States.* **H. H. Kimball.** (Monthly Weather Rev. 47. pp. 769–793, Nov., 1919.)—The paper contains much information, mainly in the form of tables and diagrams. The country is divided up into regions by considering separately the Atlantic States, Plains States, and the Rocky Mountain Plateau, in latitudes 30°, 36°, 42°, and 48° N. For each region diagrams show the solar radiation intensity at normal incidence (corrected for variation with latitude of the water-vapour content of the atmosphere), the total radiation intensity (direct *plus* diffuse) on a horizontal surface with cloudless sky, the solar illumination intensity at normal incidence, the total illumination on a horizontal surface, and the solar illumination on vertical surfaces facing N., S., E., W., N.E., S.E., N.W., and S.W. In each case the diagram consists of isopleths with hour angles of the sun as ordinates and days of the successive months as abscissæ. A further set of diagrams, in the form of maps of the United States, show by means of radiation isograms the average daily totals of radiation received on a horizontal surface on the 21st of each month, and a second set the same with a cloudless sky. Other things considered are the variations in daily totals with altitude and cloudiness, and the effect of slope of the land on the radiation intensity received. M. A. G.

1139. *Latitude Variation. Preliminary Greenwich Values for* 1919. (Roy. Astron. Soc., M.N. 80. pp. 454–455, March, 1920.)—Bad weather in March and December reduced the number of plates obtained. The list of pairs of stars was revised, omitting some too bright and others too faint, and some whose mean zenith distances had become too great owing to precession. The value of the latitude variation was smaller than in any years since 1900, and the following corrections to observed N.P.D.'s are derived :—

1919	Jan. 1....	−0·10″	1919	Aug. 1....	+0·04″
	Feb. 1....	− ·09		Sept. 1....	+ ·04
	Mar. 1....	− ·07		Oct. 1....	+ ·04
	April 1....	− ·04		Nov. 1....	+ ·04
	May 1....	− ·02		Dec. 1....	+ ·04
	June 1....	+ ·01		Jan. 1....	(+ ·03)
	July 1....	+ ·03			

W. W. B.

1140. *Latitude Variation at Matuba, Cabinda (Portuguese Congo).* **C. Sanders** and **H. S. Jones**. (Roy. Astron. Soc., M.N. 80. pp. 455–463, March, 1920.)—The observations, made between 1917 Nov. and 1919 April, are considered to be the first of their kind so near the equator (S. Lat. 5°·17′), and more are wanted, especially in relation to the *z*-term of latitude variation. A comparatively small instrument was used, and this was satisfactory, but the observing conditions in the Portuguese Congo are quite unsuitable for the chain system as used at Greenwich to be applicable. All observations had to be made in early evening. A description is given of the method of observation and the programme followed, the determination of screw errors and levels, and the reduction of the observations. The closing error, − 0·269″, is distributed among the twelve groups separated. It is involved with the Kimura term, and the authors suggest that it may be governed by local meteorology. The probable error of the result for mean of a month is given as ± 0·02″. W. W. B.

1141. *Kodaikanal Observations of Prominences.* **J. Evershed.** (Kodaikanal Obs., Mem. 1. Part 2. Nature, 105. p. 340, May 13, 1920. Abstract.)—This volume is entirely devoted to a description and photographs of solar prominences made by the director and his wife, with discussion of distribution and motion. He attributes their preponderance at the E. limb to an earth effect. In addition to the prominences associated with the spot-zones he finds high-latitude zones of prominences which start from about latitude 50° soon after sun-spot maximum, and travelling away from the equator reach the pole about the next maximum. They are less active than those of the spot-zones, but the changes of the corona round the pole in the solar cycle may be due to them. The prominences rotate more rapidly than the photosphere. Their structure appears to be very tenuous, and their light may be due to energy absorbed from the intense solar radiation. W. W. B.

1142. *Planetary Families of Comets.* **H. N. Russell.** (Nature, 105. p. 467, June 10, 1920. Paper read before the Am. Astron. Soc.) —The orbits of the six comets of the Neptune group pass nearer to the orbits of Jupiter and Saturn than to that of Neptune, hence they were possibly captured, not by Neptune, but by Jupiter. Thirty-six comets of less that 10-year periods, except Encke's, have orbits passing within 0·65 of Jupiter's orbit, 17 of them within 0·15. Thirty-one comets have periods between 10 years and 1000 years. Seven of them pass within 0·5 of Jupiter's orbit, five within 0·5 of Saturn's orbit, and two within 0·5 of Uranus' orbit. The nearest approach to Neptune's orbit is 1·22. On the hypothesis of chance approach within 0·5 of these four orbits, of these 31 comets there should be 6 for Jupiter, 3 for Saturn, 1½ for Uranus, and 1 for Neptune. The author concludes that there is very little evidence of capture. *Nature* mentions some of the stronger arguments the other way, ignored by the author. W. W. B.

1143. *Great Sun-spot and Magnetic Storm,* 1920 *March* 22–23. **A. L. Cortie.** (Roy. Astron. Soc., M.N. 80. pp. 574–578, April, 1920.)—The author traces the life history of this spot from its first appearance on 1919 Dec. 27, until its fourth, which covered the great magnetic storm. Similarly, the magnetic effects gradually increasing at 27-day intervals, till the violent disturbance of March 22. He considers the intensity of the outburst to be due to three favourable conditions coexisting. The earth near the equinox was in low heliographic latitude, corresponding to spot-zones, the phase of the sun-spot period had brought the spots into a latitude nearly the same as that of the earth, and a presumed highly-charged condition was prevailing in the earth's upper atmosphere reinforced at successive solar rotations waiting for a sufficiently violent solar disturbance to upset equilibrium, as indicated by the violent and large oscillations of the magnets. W. W. B.

1144. *Secular Accelerations of Sun and Moon as determined from Ancient Lunar and Solar Eclipses, Occultations, and Equinox Observations.* **J. K. Fotheringham.** (Roy. Astron. Soc., M.N. 80. pp. 578–581, April, 1920.)—A paper by H. Jeffreys [see Abs. 688 (1920)] hints that perhaps half the solar acceleration is in error, so the present author, whose computed value is in question, now collects together the results of different kinds of observations used for the purpose: (1) Times of lunar eclipses. (2) Magnitudes of lunar eclipses. (3) Solar eclipses. (4) Occultations and conjunctions, and (5) Equinox observations. He concludes that the lunar acceleration is about $+ 10\cdot5''$, and the solar acceleration a trifle more than $+ 1\cdot0''$. W. W. B.

1145. *Heliographic Positions of Sun-spots.* **E. D. Roe.** (Astron. J. 33. pp. 1–8, May 27, 1920.)—The observations are made directly with a micrometer, the distances of a spot from two tangents to the limb at right angles to each other being read off by the revolutions of the screw which moves the wires. They can then be referred to the usual axis through the centre of the disc by subtracting from the measured radius and transforming from the fixed position of the micrometer to the diametral plane. Details are given of the transformation from conical to orthogonal projection, and other formulæ for the solution of the measures. The method can be applied to the measurement of photographs of the sun, and the distances between points on the moon, and the author claims various advantages for his method, even as against photography. W. W. B.

1146. *Relative Depth of Galactic Plane.* **R. I[nnes].** (Union Observat. S. Africa, Circ. No. 47. pp. 36–37, Dec. 10, 1919.)—It is generally assumed that star density is greater towards the galactic equator. The author takes the polar square degree as bounding the first volume and as an average sample of the stellar universe as regards density and distribution of magnitudes, looking into another latitude where the assumed density is 1·58 times as great ($\log 1\cdot58 = 0\cdot2$). Then in the added depth the stars will be one magnitude fainter, and the total column $(1\cdot58)^3 = 3\cdot98$ times greater. Thus the extra volume will be 2·98, with stars one magnitude fainter. Figures are given for the next three successive depths. The results are then applied to the Groningen figures. The author finds on the assumption of polar density only, the number of stars of 15th magnitude in the galaxy to be 2073, while the Groningen table gives 1845. Thus the original assumption of increasing density is not borne out by the facts. If the density increased with the distance, the discrepancy would be greater. The author concludes that if the stellar universe is ellipsoidal its ellipticity cannot be large. Possibly the galaxy is additional to the stellar system in general. [See Abs. 1173 (1919).] W. W. B.

1147. *Extension of Calcium Envelope Hypothesis.* **W. C. Rufus.** (Roy. Astron. Soc. Canada, J. 14. pp. 139–140, May, 1920.)—Certain spectroscopic binaries show H and K lines (Ca) almost fixed, suggesting a quiescent envelope of Ca, within which large relative motions of other gases take place. The author has been investigating χ Aurigæ to test the possibility of a similar envelope of hydrogen. H_γ and H_δ, with eleven lines of He, Si, C, and Mg, were used in Young's determination of mean radial velocity, so the method tried has been to compare this with the velocity indicated by the H_γ and H_δ alone. Eighty-eight plates were used, and show a probable H-velocity curve 2 km. higher at minimum and 3 km. lower at maximum. This range is one-eighth of the mean velocity value of 41 km., and would be larger but for the inclusion of H_γ and H_δ in Young's determination; and so far the idea of a hydrogen envelope is supported, but more evidence is required.
W. W. B.

1148. *Stellar Magnitude Scales of Astrographic Catalogue.* XIV. **H. H. Turner.** (Roy. Astron. Soc., M.N. 80. pp. 620–623, April, 1920.)—This is the author's fourteenth note on the subject, and deals with Perth magnitudes for zone − 36°. He compares his analysis with the neighbouring zones, − 32°, − 34° to the north, and − 38°, − 41°, − 42°, and − 43° to the south, and suggests an equiangular spiral for the distribution, but there is a break of continuity between the present zone and the two to the north, so that the distribution may vary with declination. More zones to the north will be required to test this. W. W. B.

1149. *Helium Lines in Novæ.* **F. E. Baxandall.** (Observatory, No. 552. pp. 192-194, May, 1920.)—Adams and Joy having criticised the author's conclusions [see Abs. 549 (1920)], he now replies to the effect that his remarks did not refer to He generally, but to two "parhelium" lines in particular. He now goes further, and thinks that enhanced lines of Fe are a more probable interpretation of the "parhelium" pair, and that what they suggest as λ4472 of He is more likely to be enhanced Mg at λ4481, on the ground that on the date referred to (June 11th) almost the whole spectrum of Nova Aquilæ consisted of enhanced lines. At later dates he admits distinct evidence of the λ4471·6 He line, with a large displacement in agreement with those of O and N lines. W. W. B.

1150. *Change in Period of Mira Ceti, S Herculis, and R Leonis.* **H. H. Turner.** (Roy. Astron. Soc., M.N. 80. pp. 604–617, April, 1920.)—The first of these stars has been observed for more than three centuries. All have been under continuous observation for a considerable time, and their periods are of the order of 10 or 11 months. Mira (Phillips, Group II) shows eight changes of period since 1596, but they are of oscillatory character, showing no certain secular change. S Herculis (Group I) also oscillates, but the evidence does not contradict similar increase. R Leonis, which Phillips classes Group I and Turner Group II, after oscillation has recently shown an increase in period, and, the author thinks, may perhaps be returned to Group I. The net result of the three does not confirm the tentative law—Group I increasing period, Group II decreasing—but they do confirm the idea of a change of phase or period at regular intervals, given respectively as 6600, 4600, and 5000 days. W. W. B.

1151. *Capture Orbits.* **L. Becker.** (Roy. Astron. Soc., M.N. 80. pp. 590–597, April, 1920.)—The method of calculation is that of mechanical quadrature of the differential equations of motion of three bodies in a plane. If these are of approximately equal mass, two forming a binary system, while the third is approaching it, then this third body, if it acquires elliptical velocity, may become a member of a new binary system at the expense of one of the other two bodies, which has to recede with hyperbolic velocity. Five different possible orbits are given.
W. W. B.

1152. *Capture Hypothesis of Binary Stars.* **L. Becker.** (Roy. Astron. Soc., M.N. 80. pp. 598–603, April, 1920.)—To test the hypothesis in the preceding paper [see preceding Abs.], which accounts for the large eccentricities found in many binary orbits, the suggestion is made that though it is exceedingly unlikely that a third body will approach a binary in its plane, yet the Two-star Stream Theory assumes that many stars are moving in approximately parallel paths, so that there is reasonable expectation of a symmetrical distribution. Thus the major axes of known binaries should on this hypothesis show symmetrical distribution about the *vertex* of the relative motion. The 87 binaries in Aitken's book, some of them corrected by Jackson, have been examined for this, and a distribution curve results, which is symmetrical about R.A. 110°, positive declinations predominating. W. W. B.

1153. *Masses of the Stars.* **H. N. Russell.** (Nature, 105. p. 500, June 17, 1920. Paper read before the Am. Astron. Soc.)—Method I. Visual binaries, known orbit and parallax. Method II. Known parallax and relative motion, but not orbit. Method III. Spectroscopic binaries, showing both spectra, assuming mean inclination. Method IV. Uses parallax derived vaguely from proper motion.—Resulting mean masses of pairs :—

Spectrum.		I.	II.	III.	IV.
B_0–B_5		—	10·4	17·5	7·1
B_6–A_5		5·9	3·0	4·0	8·4
F–G	giant	—	—	3·9	8·1
K–M		—	—	—	9·8
F–F_5	dwarf	3·5	3·4	—	2·5
F_8–K_0		1·8	1·4	—	0·7
K_5–M		0·7	1·0	—	—

Formulæ are given for hypothetical parallax, involving a constant whose value is different for different classes of stars. W. W. B.

1154. *Duplicity of ν Geminorum.* **Bernewitz.** (Astr. Nachr. No. 5041. Nature, 105. p. 340, May 13, 1920. Abstract.)—This spectroscopic binary, according to computations at Ottawa, has a period of 9·6 years and projected elongation 1400 million km., a value so large that it was thought possible it might be a visual binary. Four observers at Berlin-Babelsberg Observatory examined the star with the 65-cm. refractor, and all agreed that the star is distinctly elongated. With a graduated dark wedge it was found to become round before extinction, so a difference of 1 magnitude between the two components is suggested. Observations by two observers on five nights give mean position angle 120° and distance 0·15″. It appears to be near elongation. If sufficient visual observations can be made, the mass and parallax may be found, and as it is a B5 star, the mass determination should be of great interest. W. W. B.

1155. *Double Star Notes.* **[Miss] Cannon, E. Bernewitz** and **F. Pavel.** (Harvard Circ. No. 221. Observatory, No. 552. p. 203, May, 1920.)—Miss Cannon gives a list of 116 stars of composite spectra, bringing her total of such to 261. Of the 116, forty-three have already been announced as visual double stars; but most of the remaining 73 are probably too close for measurement, except as spectroscopic binaries. Of the 43, some probably have one component too faint to give a spectrum, in which case the other would appear to be a spectroscopic binary. E. Bernewitz and F. Pavel (Astron. Nachr. No. 5041) give observations of ν Geminorum as a visual double star at Berlin-Babelsberg Observatory. It is known to be a spectroscopic binary with a period of 9·6 years, and the separation appears to be a maximum in 1920 and 1921. W. W. B.

1156. *Spectra and Radial Velocities of Long-period Variables.* **P. W. Merrill.** (Astron. Obs. Univ. of Michigan, Publ., vol. 2. Review in: Observatory, 43. No. 552. pp. 201–203, May, 1920.)—Spectroscopic observations of stars of Class Md. This almost doubles the number of velocities of these dark-line stars known, bringing it up from 24 to 43. No instances of variable velocity are found. The average residual velocity, 32 km., makes the Md stars the swiftest known class. The 43 stars seem to have a systematic motion towards the solar antapex, and the fainter stars more than the brighter ones. The relative displacement of the dark and bright lines suggests to the author a " veil " theory, by which at minimum a screen of condensing gases, such as Ca, is developed in the star's outer envelope; the actual brightness of the star meanwhile being supposed not to vary much, and the relative displacements of dark and bright lines being attributed to pressure. W. W. B.

1157. *Naked-Eye Observations of Nova Aquilæ III.* **E. E. Barnard.** (Roy. Astron. Soc., M.N. 80. pp. 582–586, April, 1920.)—The author reserves his telescopic observations for the present, but refers to notes on the peculiarities of the nova [see Abs. 860 (1919)]. He was one of the early independent discoverers of the nova, and considers that claims dated previous to June 8, 1918, refer not to the nova, but to a neighbouring star. Between 1892 and 1917 he obtained on 54 dates photographs which on examination show the nova. He gives all his estimates of brightness from discovery to Nov. 6, 1918, with the numbers of stars used for comparison, and notes on one of them, the double star θ Serpentis, as to whose brightness there is disagreement between different catalogues, and a suggestion of variability which the author does not support. He notes that in the spring of 1919 the nova was of a beautiful bluish-green, unlike any star in the sky. W. W. B.

LIGHT.

1158. *Suspended Zenith Telescope of Durham Observatory.* **E. H. Hills.** (Roy. Astron. Soc., M.N. 80. pp. 564–574, April, 1920.)—As an alternative to the principle of the Cookson floating zenith telescope, the author has adopted that of suspension on gimbals, claiming that in all positions the vertical through the centre of gravity of the hanging part of the instrument is unaltered, and that this can easily be adjusted to pass through the centre of the photographic plate. The aperture is 8 in. and focal length 56 in. It can be clamped in two positions 180° apart, and vibration is damped by a vane dipping in a glycerine dashpot. Full details are given, and it is shown that errors of level, tilt, eccentricity, and orientation can be reduced to negligible amounts, and that instrumental displacements due to magnetic attraction, capillarity in dashpot, or varying size of plates are completely negligible. There remains the effect of temperature for which study of resulting photographs, not yet obtained, is necessary. The intention is to provide an instrument, readily portable, which could spend a year at a time at different observatories, and thus supplement the continuous record of latitude variation at Greenwich and the International Latitude Stations.
W. W. B.

1159. *New Microphotometer for Photographic Densities.* **W. F. Meggers** and **P. D. Foote.** (Optical Soc. of America, J. 4. pp. 24–34, Jan., 1920.)—The instrument is essentially the micropyrometer described by Burgess [see Abs. 621 (1913)] except that a microscope of higher power is employed. The photographic plate is mounted just below the objective of the microscope on a horizontal bed, movable with a graduated screw, and is illuminated beneath by an intense beam of light from a tungsten-ribbon lamp. Light transmitted by a small portion of the photographic plate, the image of which is adjacent to that of the tip of the pyrometer-lamp, is matched with equal filament brightness by adjusting the current through the lamp. The ammeter readings are readily translated into measurements of photographic density. If the tip of the pyrometer lamp filament be regarded as a filar in the eyepiece, the relative positions or wave-lengths of spectral lines on a plate are measured at the same time that their photographic densities are measured. An example of the use of this microphotometer for measuring wave-lengths and densities of spectral lines is given, and it appears that the visually estimated intensities of such lines form a geometric series in accordance with Fechner's law. Illustrations of the application of this microphotometer to the measurement of energy distribution in a broad spectral line and to the measurement of spectral sensitivity of a photographic plate are given. Measurements of photographic density when the plate is illuminated by parallel light are found to be much larger than when the illumination is diffuse. This experience calls attention to the importance of specifying the character of the illumination when measurements are made on light transmission of differing media.
A. E. G.

1160. *Étalons with Silvered Surfaces.* **C. Fabry** and **H. Buisson.** (J. de Physique, 9. pp. 189–210, June, 1919.)—Several new forms of étalons are described, the properties of the silvered surfaces being indicated, and the mode of preparation given in detail. The methods which can be used for the measurement of these étalons are also described. All the forms dealt with are, in principle, of the same type, the surfaces being separated by three blocks, with adjustment by local deformation produced by means of springs. Arrangements are shown applicable to étalons of small thickness, and also others suitable for étalons with a large distance between the plates. As regards the silvered plates, which were prepared by kathodic deposition, an account is given of the apparatus used for measuring the reflecting power and the transmission of the metallic layers. A table shows how these two quantities, as well as the properties of the fringes, depend on the thickness of the layer. Among the methods used for measuring the étalons the authors have particularly studied one which allows of the equalisation of two path differences by inclining the étalon which has the greater path difference. This method seems to be the most direct and simple for comparing an étalon with another whose thickness is nearly a multiple of that of the first. The method gives very good results even when the ratio of thicknesses reaches the value 5, and can be used for the value 10. A. W.

1161. *New Soft-Focus Screen for Portrait Photography.* **C. W. Frederick.** (Optical Soc. of America, J. 4. pp. 44–48, March, 1920.)—In portrait work it is not always desirable that a lens should give sharp definition, because marks and blemishes are brought out too clearly. The smoothing out of defects is usually done by retouching the negative, or by employing a lens with soft definition, or both. It may be produced by merely throwing the lens out of focus, but the effect is not pleasing because the definition is obliterated too completely. The usual method of producing soft definition is to modify the design of the lens so that it will fall off in spherical aberration. Thus the image formed by light passing through an outer zone of the lens will not be at the same distance as that formed by light passing through the central portion of the lens, and intermediate images will be formed at intermediate points, so within a certain range a part of the light will form a sharp image and the remainder a series of superposed fuzzy images. The character of the effect will depend upon the distribution of light in the sharp and the fuzzy images, which distribution may be influenced by lens type and different adjustments as to spherical aberration. But the nature of spherical aberration places certain limitations upon the problem. The natural distribution of light due to spherical aberration may be modified by interposing an opaque diaphragm with a small central opening to allow the sharp image to be formed and radial openings to control the amount of light in the diffuse image. Such a device has, however, the disadvantage of slowing down the lens to an inconvenient degree. It was the study of the action of such a diaphragm that suggested the new diffusing screen described in this paper.

After many experiments a screen was settled upon in which there are three systems of linear grooves ground at angles of 120° from each other, and the grooves of each system are spaced at equal intervals apart but are progressively of increasing depth from the centre outward. The finished pattern shows hexagonal areas of clear glass constituting about two-thirds of the area of the entire screen. Thus two-thirds of the light is allowed to form a sharp image, and the remaining one-third

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a succession of soft images varying in diffuseness according to the depth of the successive grooves on the screen. The screen gives soft effects without a trace of double lines, and at the same time it gives definition that does not fail under a magnifier. Its effect may be slightly modified by stopping down the lens. The results obtained with this screen are better than anything that could be done with a soft-focus lens. A fundamental property of all the screens consisting of systems of straight lines is that the diffusion occurs at right angles to the various systems, and does not occur equally in all directions. The results obtained seem to indicate that the problem of direct taking is somewhat different from that of enlarging and will require a different type of screen. In direct taking the screen causes the white areas to encroach upon the black, producing an effect similar to halation; in the case of enlarging, the black areas encroach upon the white and do not produce the effect of halation. However, by limiting the diffusion and modifying its distribution it is quite likely that a satisfactory screen may be developed for direct photography. A. E. G.

1162. *Relative Merits of Monocular and Binocular Field Glasses.* **E. P. Hyde, P. W. Cobb, H. M. Johnson, W. Weniger.** (Frank. Inst., J. 189. pp. 185–223, Feb., and pp. 331–369, March, 1920. Report of Sub-Committee of the U.S. National Research Council.)—The experimental work was conducted by P. W. Cobb and W. Weniger. Comparisons, mainly from a military standpoint, are made as regards mechanical and optical design, ease of manipulation, and questions of physiological optics. The limits of toleration for non-parallelism of the optic axes of a binocular are very small, and slight disturbance of alignment by a blow or fall causes eye-fatigue. Focal adjustments, cleaning, and carriage, are also more troublesome for the binocular. The first part of the paper describes laboratory tests by scientific men; the second part practical field tests by military men. The binoculars were of the type EE, Bausch & Lomb Co., 6-power, the left limb fitted with a mil scale and an Eames aiming scale, absent in the monoculars. The tests were four in number: (1) A general daylight test, with a single man as object, (2) a twilight test, (3) a counting test in which groups of men varying in number appeared at stated places, and (4) a timing test of the interval between getting the glass from its receptacle and reporting on the object. The observers were officers, except in the timing test. Of 43 officers asked to state their preference as to type of glass, all but one chose the binocular. An analysis by "points" of the reasons for preference yielded 85 points, out of a total 107, for the binocular. Preconception in its favour may have had some effect; the exact results of the report, however, bear out the opinions in the main. A curious instance is given of the difficulty of getting accurate reports from untrained observers. A man under observation struck a match, and while a number of observers stated that "B. lit a cigarette," only one reported just what he saw, which was "a light at B." As regards visual acuity, tests by three scientific observers showed that the binocular gave no better results than the monocular used with the observer's better eye, when the mechanical convenience was equalised, a condition which does not hold in practice. As to perception of small differences of brightness, and of very faint luminous patches in the dark, laboratory work (without glasses) has shown that two eyes are better than one.

Twilight tests of visual acuity in the laboratory were in favour of the binocular, other conditions being equalised, and the practical tests do not contradict this result. Stereoscopic effect hardly seems to be of prime importance from a military standpoint; it is decidedly useful for binocular discrimination, but the authors emphasise their view that the advantage of binoculars is almost certainly largely due to other factors which have not yet been sufficiently studied, such as discrimination of small brightness differences, detection of motion, and in general the part played by the peripheral retina. After four or five days' practice with the monocular, the differences in performance between the two types of instrument tended rather to increase than diminish. So far as cost and speed of production are concerned, the advantage naturally is greatly in favour of the monocular. The monocular requires 1·5 to 2·0 seconds less to move from its carrying place to the eye, but the binocular is quicker in picking up an object by about 0·4 sec. In the hands of observers not highly experienced the binocular performs slightly better than the monocular; the difference may be expressed by the statement that a binocular of magnification 6·00 would perform as well as a monocular of mag. 6·27. Such a difference was evidently not regarded by the military authorities as of paramount importance, since 6-power glasses were adopted as standard, though two years' tests at Ft. Sill, Oklahoma, clearly indicated a power of 8 as best for field artillery work. It is considered that in many phases of military work monoculars can be used to advantage. A. E.

1163. *Variable Deviation Prism.* **H. Erfle.** (Zeits. f. Physik, 1. 1. pp. 57–81, 1920.)—If a prism be cut in two by a plane bisecting its vertical angle, the deviation may be varied by rotating one half about the axis perpendicular to the plane of bisection. The paper deals with the mathematical theory of this device and also considers the case when the surfaces of section of the two halves are no longer maintained parallel, but are inclined to each other at an angle equal to the semi-vertical angle of the original prism. J. W. T. W.

1164. *Effect of Object Distance on Astigmatism and Aberration.* **W. Merté.** (Zeits. f. Physik, 1. 2. pp. 174–190, 1920.)—Discusses the variation of aberration and astigmatism with the distance of the object from a lens system. The curves expressing this relationship are calculated for a Zeiss-Planar lens as an example. J. W. T. W.

1165. *Diffraction of Waves by a Straight Edge.* **W. G. Bickley.** (Phil. Mag. 39. pp. 668–672, June, 1920.)—Gives a simple mathematical solution of the problem of the diffraction of a wave obliquely incident on a semi-infinite screen with a straight edge, the direction of propagation of the wave being perpendicular to the edge. J. W. T. W.

1166. *Studies in Photographic Science.* **H. J. Channon.** (Phot. J. 60. pp. 164–173, April, 1920.)—This paper gives an account of the results of investigations likely to possess some interest for those who are following the scientific side of photography. The following are some of the problems considered:—(1) The influence of time upon the latent image; the one thing about this which is certain is that I × *t* is not constantly proportional to the photographic effect. (2) The mysterious Claydeneffect, which shows that so strong is the negative action of feeble light, that the condition of reversal and incapacity of receiving any further impression by subsequent exposure is produced by a combination of exposures which may be extremely small as compared with what would be required to show reversal if either the strong or the weak intensity were used alone. (3) The Russell-effect, which in these investigations has been limited mainly to the action of zinc on photographic films. (4) Sabatier's polarisation, or the reversal which takes place when a plate partially developed is exposed to white light. (5) The influence upon the results obtained which the presence of a glass surface in contact with the film during exposure may have. A. E. G.

1167. *Formulæ in Telephotography.* (Nature, 105, p. 488, June 17, 1920.)—The writer suggests three formulæ for use in telephotography—(*a*) for the full circle of illumination, (*b*) for the circle of equal illumination, (*c*) for the mean circle of illumination, and these he considers to be applicable in all cases. The equations were made on the following assumptions: (1) that the lenses are thin; (2) that the aberrations may be neglected; (3) that the focal lengths of the two lenses used are definite quantities. J. W. T. W

1168. *Optic and Electric Axes of Symmetry of Monoclinic Crystals.* **H. Rubens.** (Zeits. f. Physik, 1. 1. pp. 11–31, 1920.)—Describes research on the position of the optic and electric axes of adularia, gypsum, augite, and cane sugar. The results obtained show that if the position of the optic axes is found by using long-wave mercury-vapour radiation ($\lambda = 0\cdot3$ m.m.), good agreement is obtained with the position of the electric axes. A. W.

1169. *Michelson's Experiment.* **A. Righi.** (N. Cimento, 18. pp. 91–106, Sept., 1919. Comptes Rendus, 170. pp. 497–501, March 1, 1920.)—The author here continues his argument [Abs. 1498 (1919)] that, subject to his use of Huyghens' principle being legitimate, no visible effect was to be anticipated from the Michelson experiment, and that consequently the null result has no evidential value for or against longitudinal contractions on the theory of relativity. G. W. DE T.

1170. *Michelson's Experiment.* **J. Villey.** (Comptes Rendus, 170. pp. 1175–1178, May 17, 1920.)—The author points out that when Righi's conditions [Abs. 1498 (1919)] are rigidly fulfilled no fringes will be observable. He shows that when the necessarily finite conical angle of the incident beam is taken into account, then, over so wide a range as to impose but negligible restriction, the classical result will follow directly from Righi's formulæ. G. W. DE T.

1171. *Einstein Effect in the Sun's Gravitational Field.* **L. Grebe** and **A. Bachem.** (Zeits. f. Physik, 1. 1. pp. 51–54, 1920.)—Describes further measurements of some of the lines of the so-called cyanogen band. In earlier work [Abs. 1504 (1919)] a shift was observed of smaller magnitude than was to be expected from Einstein's theory. In the present work a registering microphotometer was used, and the results obtained for the shift of the lines used are in good agreement with theory, both as regards sign and magnitude. It was found that it is necessary to use only those lines which are of a high degree of purity, and not confused by the close proximity of other lines of slight intensity. A. W.

1172. *Intensity Distribution in Series Spectra.* **J. Franck.** (Zeits. f. Physik, 1. 1. pp. 2–10, 1920.)—A theoretical discussion of the intensity of series lines in various spectra, based on the results of Holtsmark [Abs. 753 (1919)], Stern and Vollmer [Abs. 879 (1919)], Merton and Nicholson [Abs. 1506 (1919)], and others. The discussion leads to the conclusion that Bohr's theory requires adjustment to explain the results observed. A. W.

1173. *Light Emission from Atoms due to Electronic Impacts.* **R. Seeliger and G. Mierdel.** (Zeits. f. Physik, 1. 4. pp. 355–364, 1920.)—A continuation of previous work [Abs. 1503 (1919)]. The present paper describes an experimental determination of the "excitation function." The results obtained are presented graphically. With hydrogen the Balmer series and the many-lined spectrum were investigated. It was found that the maxima of the excitation functions of the Balmer lines occur at considerably higher velocities than for the many-lined spectrum. The Balmer lines again show differences, in that the maximum occurs at higher velocities as the term number increases. In the investigation of mercury lines it was found that the maximum of the excitation function occurs at higher velocities the higher the charge on the carrier to which the line in question is due. Thus the maxima for $\lambda 4358$ and $\lambda 4047$, both belonging to the second subordinate series of triplets, and the carriers for both being doubly charged, are both found at about 28 volts. The maxima for $\lambda 4347$ and $\lambda 4078$, the carriers for both being trebly charged, are at about 50 volts, and the maximum for $\lambda 4339$, whose carrier has a still higher multiple charge, is at about 90 volts. To these results various corrections have to be applied, and the values finally obtained for the various lines dealt with are given below :—

Balmer series	$H\beta$, 90; $H\gamma$, 120; $H\delta$, 150 volts.
Many-lined spectrum of hydrogen	40 volts.
Hg $\lambda 4358$, $\lambda 4047$	30 volts.
Hg $\lambda 4347$, $\lambda 4078$	60 volts.
Hg $\lambda 4339$	>80 volts.

A. W.

1174. *Atomic Theory and Low-Voltage Arcs in Cæsium Vapour.* **P. D. Foote and W. F. Meggers.** (Phil. Mag. 40. pp. 80–97, July, 1920.)—On the basis of several possible theories of atomic structure, it is shown that the *normal* operation of an arc below ionisation might result in the excitation of a single-line spectrum, a single-series spectrum, or a group spectrum consisting of certain lines of different series. This latter conclusion follows from an extension of Bohr's theory. Thus, if inelastic electronic-atomic impact occurred, resulting in the ejection of an electron to the pth ring, the electron in returning to the nth ring or equilibrium may produce any combination of lines represented by inter-orbital transitions within this range, the single-line spectrum being a special case where $p = n + 1$. A simple explanation is offered of fluorescence phenomena in vapours of the alkali metals. A mechanism of absorption of radiation is described, and the theory proposed by K. Compton (that the ionisation of an atom below the ionisation potential may be explained by absorption of radiation arising in other atoms from electronic-atomic impact of insufficient energy to ionise) is further discussed. This hypothesis suggests that vapours of the alkali metals may be so stimulated that the first and second subordinate series lines, instead of the principal series, tend to become absorption lines.

The cæsium spectrum was photographed for various accelerating voltages, from λ3878 to λ9208, by use of dicyanin-stained plates. The sensitivity of the plates was investigated by density measurements of the spectrum of a black body having a known energy distribution. The general characteristics of the plates were determined and all lines of the cæsium spectrum were reduced to an absolute scale of intensity by means of density measurements made with a microphotometer and consideration of the plate sensitivity. No evidence of group or single-series spectra could be obtained. Thus the ratio of intensities of the first and second lines of the principal series, both of which should appear in a single-series spectrum, or above 2·7 volts in a group spectrum, rapidly approaches infinity as the accelerating potential in the arc is decreased. This ratio is 350 in a 7-volt arc, 2100 at 4 volts, 10,500 at 3·4 volts, and as near infinity as can be measured at 2·8 volts. Similarly, the intensity ratio of either $1 \cdot 5s - 2p_1$ or $1 \cdot 5s - 2p_2$ to any other line approaches infinity at low voltage, proving for the first time the existence of a single-line spectrum rather than a single-series or group spectrum —in the case of cæsium the doublet λ8521 and λ8943. The doublet $1 \cdot 5s - 2p_1$, $1 \cdot 5s - 2p_2$ is alone produced under excitation of 1·5 to 3·9 volts accelerating field. The intensity of both of these lines gradually increases, approximately proportional to the total number of electrons reaching the anode, until the ionisation potential is reached. At this point a pronounced decrease in intensity of these two lines occurs, amounting to the factor one-third. This decrease takes place at the voltage at which the complete line spectrum is produced, and is readily explainable on the basis of Bohr's theory. Thus the lines $1 \cdot 5s - 2p_1$, $1 \cdot 5s - 2p_2$ are the result of inelastic collision with electrons having velocities between 1·45 and 3·9 volts, but as the latter voltage is exceeded, electrons which at a slightly lower velocity would have given rise to these lines now produce the complete-series spectrum; and any line of the series $1 \cdot 5s - mp_1$, $1 \cdot 5s - mp_2$, where $m > 2$, is necessarily excited at the sacrifice of $1 \cdot 5s - 2p_1$, $1 \cdot 5s - 2p_2$. Above a certain voltage the intensity of any line per unit number of electrons reaching the anode attains a saturation value in agreement with the quantum hypothesis, which requires that the number of quanta radiated be proportional to the number of collisions, and hence (approximately) to the number of electrons present. Curves are given showing the relative intensities of the prominent cæsium lines at various voltages. The ratio of intensities of the components of the first doublet of the principal series (λ8521, λ8943) is constant and equal to 1·5 from 1·5 volts to 120 volts. The cæsium arc of the type employed does not rectify alternating current of 120 volts.

Sodium and potassium occurring as an impurity of the cæsium similarly exhibited the single-line or doublet spectrum $1 \cdot 5s - 2p_1$, $1 \cdot 5s - 2p_2$ below their respective ionisation potentials.

Only two types of inelastic impact between electrons and atoms of the alkali-metal vapours occur, at potentials known as the resonance and ionisation potentials, and given by the quantum relation $h\nu = e\text{V}$, where $\nu = 1 \cdot 5s - 2p_1$ and $\nu = 1 \cdot 5s$. A. W.

1175. *Light Absorption and Fluorescence.* V. E. C. C. Baly.—(Phil. Mag. 39. pp. 565–577, May, 1920.)—This paper discusses the so-called molecular rotational frequencies of water. In a previous paper [Abs. 891 (1916)] it was shown that the whole of the absorption bands given by sulphur dioxide can be expressed in terms of three fundamental frequencies, one of which ($2\cdot4531 \times 10^{11}$) is characteristic of the atom of oxygen, while the others ($8\cdot19 \times 10^{11}$ and $1\cdot296 \times 10^{12}$) are characteristic of the atom of sulphur, since the infra-red absorption bands of oxygen can be expressed in terms of the first, and those of sulphur and hydrogen sulphide in terms of the last two constants. The combination of these three constants to give the frequencies characteristic of SO_2 seems to be of great importance, for it affords a very complete example of the least common multiple principle which forms the basis of the frequencies of absorption bands. Sleator has recently published highly accurate measurements of water-vapour at 6μ and 3μ [Abs. 1150 (1918)], and it is now possible to test whether a structure similar to that found in SO_2 exists in the absorption spectrum of water-vapour. Further, if the atomic frequency $2\cdot4531 \times 10^{11}$ is truly characteristic of the oxygen atom, this value should form one of the atomic frequencies which is active in the case of the molecule of water. From results of Bjerrum and Miss von Bahr three atomic frequencies ($1\cdot0635 \times 10^{11}$, $2\cdot1157 \times 10^{11}$, and $2\cdot4531 \times 10^{11}$) are obtained for water, and various tests are applied which show a remarkable agreement between the values calculated from these atomic frequencies and the wave-lengths of the first and second series of sub-groups of bands observed by Sleator. These facts, together with further similar evidence from the absorption spectra of naphthalene, benzene and the olefines, are in direct conflict with the theory that molecular rotational frequencies play a fundamentally important rôle in absorption spectra. Two criticisms may at once be made of this theory as it stands. In the first place, the inexactness of the rotational frequencies is thoroughly unsatisfactory; and in the second place, it has been shown that the sub-groups due to the so-called rotational frequencies have also a structure arising from the existence of frequencies far slower than the rotational frequencies. It is difficult to conceive of any vibrations exhibited by a molecule, as a whole, which are far less rapid than its rotations. Krüger [Abs. 14 (1917)] has proposed an alternative theory in that he substitutes precessional motions for the rotational velocities, but there are strong objections to this theory also. The most important fact to be considered in discussing these two theories is that the so-called molecular frequencies are due to small groups of atoms within the molecule, and that they are the least common multiples of the frequencies characteristic of these atoms. Further, the same atomic frequencies are shown by the same elementary atoms in different compounds—*e.g.*, oxygen in SO_2 and in water, and sulphur in H_2S and in SO_2. When two or more atoms enter into chemical combination, the resulting molecule is endowed with a frequency which is the least common multiple of the atomic frequency of all its atoms. The molecule also exhibits as subsidiary frequencies both the least common multiples of the frequencies of groups of atoms forming a component part of itself, and also the atomic frequencies themselves. Development along these lines seems to afford much greater promise than either Bjerrum's or Krüger's theory. Attention is drawn to the fact that the central wave-length of the water band at $3\cdot06\mu$ *is* $3\cdot06\mu$, and not $3\cdot26\mu$ as often stated.
A. W.

1176. *Precision Measurements in X-ray Spectra. K-series, Elements Cu to Na.* **E. Hjalmar.** (Zeits. f. Physik, 1. 5. pp. 439–458, 1920.)—The author describes a method of measuring X-ray wave-lengths with considerable accuracy, and applies it to the determination of the frequencies of the K-series spectra of the elements copper to sodium. A calcspar crystal was employed in the analysis of the K-series spectra of the elements Cu to Cl, the grating space d being taken as

$$\log 2d = 0\cdot7823347 - 8.$$

The values of wave-lengths, determined from extremely sharp spectral lines are tabulated.

In the cases of the elements from Cl to Na a crystal of gypsum was employed. Its grating space d was determined by comparison with the calcspar crystal, known wave-lengths being employed. The mean value finally taken for the grating space d for gypsum is given by

$$\log 2d = 1\cdot1805620 - 8\ (\pm 0\cdot0000149).$$

A. B. W.

1177. *Spectrometric Investigations of X-Rays.* **A. Dauvillier.** (Ann. de Physique, 13. pp. 49–134, March-April, 1920.)—The authors have previously made a study by indirect methods of the kathode-ray spectra of the discharges which take place in tubes containing gas and in the case of pure electron emission. A Blondel oscillograph has been used for the purpose of the experiments to record the fluctuations of voltage and current in the tube. The results of this investigation (hysteresis phenomena, static and dynamic characteristics) were published in 1917. By means of a Bragg spectrometer the X-ray spectra, general and characteristic, corresponding to these kathode-ray spectra have been examined, the results showing a strong similarity to those obtained by Rutherford for β- and γ-rays. In the progress of the research, the authors have incidentally verified the phenomena of absorption J, discovered by Barkla; the results now obtained have an important bearing on the theories of atomic structure and of the origin of discontinuous high-frequency spectra.

Certain apparently abnormal effects observed in a Coolidge tube have received an explanation as a result of the oscillographic study of the discharge. A comparison has also been made of the oscillographic and spectrometric results for gaseous discharge tubes and Coolidge tubes, the results having an important bearing on the phenomena observed in such tubes. The theory of J. J. Thomson relating the total energy of radiation of X-rays and the speed of electrons has been verified. An attempt is made to define the characteristics of an X-ray tube in terms of simple quantities, *i.e.*, voltage, current intensity in the tube, etc. The phenomena of the emission of X-rays by quanta has been verified for voltages from 24 to 109 kilovolts for gaseous discharge tubes with incandescent kathodes and various antikathodes (Ta, Pt, Ni). The results suggest a new method of absolute determination of spark potentials by means of the spectrum.

A. B. W.

HEAT.

1178. *Specific Heat of Carbon Dioxide and Steam.* **W. T. David.** (Phil. Mag. 39. pp. 551–553, May, 1920.)—The author suggests that the specific heat of these gases may be expected to vary slightly with density and volume at temperatures of about 1000° C., and show marked variation at about 2000°. For the specific heat depends on the translational and rotational molecular energy, both of which are, for a gas in thermal and chemical equilibrium, proportional to the absolute temperature; and also on the vibratory energy, which, as he has previously shown [Abs. 1002 (1913)] may be expected to depend on the volume and density as well as on the temperature, when radiation comes into play. And his experiments have shown that both CO_2 and steam emit radiation in appreciable quantity at about 1600° C., and very strongly in the neighbourhood of 2000° C. G. W. de T.

1179. *Properties of Fluids and their Characteristic Equations in the Neighbourhood of the Critical Point.* **G. Bruhat.** (Comptes Rendus, 170. pp. 1173–1175, May 17, 1920.)—The hypothesis of the continuity of the liquid and gaseous states may be expressed by the existence of a relation $p = f(v, T)$, valid throughout the observable domain of the fluid. This region is limited by the saturation curve, *i.e.*, at a temp. T by the specific volumes u and u' of liquid and vapour in equilibrium under the pressure p. The existence of a critical point, whose coordinates are taken as unity, is expressed by the fact that when T approaches I, u and u' tend towards I, as also p. The function f is continuous throughout the fluid domain which comprises the points of the saturation curve and the critical point, and the author assumes that its partial differentials exist up to the fourth order and are continuous under the same conditions. The pressure at a point observable in the vicinity of the critical point may then be represented by Taylor's formula as far as the fourth term. The characteristic equations are next deduced expressing the continuity of the gaseous and liquid states. The data thereby derived are compared with those obtained experimentally from the vapour-pressure curves for hydrogen, oxygen, carbon dioxide, pentane, water, and ethyl alcohol. It is shown that these numbers are in general contained between the values given by the classical characteristic equations. H. H. Ho.

1180. *Brown's Formula for Distillation.* **S. Young.** (Roy. Dublin Soc., Proc. 15. pp. 667–672, Jan., 1920.)—According to F. D. Brown (1879–1881) the relationship between the composition of a liquid mixture and that of the vapour evolved from it may in general be expressed by the formula, $m'_A/m'_B = m_A P_A / m_B P_B$, where m'_A and m'_B are the relative masses of the two substances in the vapour, m_A and m_B their relative masses in the liquid mixture, and P_A and P_B the vapour pressures of the pure substances at the boiling-point of the mixture. It is now shown that this formula is applicable without serious error to mixtures of benzene and toluene for which the formula $P = mP_A + (1 - m)P_B$ gives results nearly, but certainly not quite, correct; P here represents the vapour pressure of the mixture and m the molar fraction of substance A. T. H. P.

SOUND.

1181. *Distribution of Wind Velocity when Abnormal Propagation of Sound Occurs.* **K. Aichi.** (Phys. Math. Soc. Japan, Proc. 2. pp. 63–69, April, 1920.)—Suppose the wind is horizontal and parallel to the direction of x and its speed u is a function of the height y only. Then confining attention to the two-dimensional case, it is asked, Under *what law of the variation* of wind velocity with height will all the sound waves starting from the origin of the coordinates pass again the point $x = R$, as if the point were a focus ? Such distribution of the wind velocity will explain the abnormal intensity of the sound heard at some particular place, under favourable circumstances. Equations for the waves are then written and an approximate integral equation obtained. This is solved by successive approximations in series form and thus expresses the wind speed u as a function of the height y. [See Abs. 1166 (1917).] E. H. B.

1182. *Sound Pressure.* **E. Waetzmann.** (Phys. Zeits. 21. pp. 122–128, March 1, 1920.)—A discussion, partly mathematical, on sound-pressure and combination tones, in which the author replies to the criticisms of E. Budde. [See Abs. 1367 (1916).] E. H. B.

1183. *Most Economical Sending-Frequency for Sounds to be heard in Air and under Water.* **F. Aigner.** (Zeits. f. Physik, 1. 2. pp. 161–173, 1920.)—For sounds sent into the air to be perceived by the unassisted normal ear at close range the author theoretically obtains the value 2300 per sec. as the most economical frequency. For a distance of 10 km. this value sinks to 1000 per sec. These values for close range and 10-km. distance become respectively 1000 and 200 per sec. when the ear is assisted by a resonating receiving antenna.

For sounds in *water* to be heard by the unassisted ear inside about 2000 km. the frequency 2300 per sec. is calculated to be most favourable, and for the assisted ear at the same range the frequency of 1000 per sec.

The experimental confirmation of these theoretical results for the air have not yet been obtained. Neither have those for the unassisted ear in water. But for submarine telegraphy by assisted hearing the observations are in good accord with the theoretical results. E. H. B.

1184. *Photographic Method of Finding the Instantaneous Velocity of Sound Waves near their Source.* **A. L. Foley.** (Nat. Acad. Sci., Proc. 6. pp. 310–312, June, 1920.)—Sparks from condensers, L L, pass across gaps G G, the sound gap S, and the illuminating gap I. The light from I casts a shadow of the sound wave (produced at S) upon the photographic dry-plate P, provided the spark I occurs at the proper time. The gaps I and S are in series, the spark S occurring first, that at I being retarded the proper time interval by means of an adjustable condenser K. A disc with irregular teeth on its edge is rotating rapidly so as to give shadows on the lower edge of the photographic plate and thus enable the time interval to be measured between the sparks at S and I. It is found that the velocity varies from about 660 m. per sec. at a distance of 3·2 mm. from the sound source to 380 m. per sec. at a distance of 18 mm. Full details of extended measurements are promised in a later paper. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1185. *Kinematical Interpretation of Electromagnetism.* **L. Page.** (Nat. Acad. Sci., Proc. 6. pp. 115–122, March, 1920.)—The author shows that the equations of electrodynamics may be interpreted exactly and in their entirety as kinematical relations between the elements moving with the speed of light which constitute lines of force, provided use is made of the space and time transformations of relativity. Each charged particle must be considered to have its own field, extending to infinity in all directions, the resultant field at any point being a combination of those fields which extend to the point in question. Four out of the five electrodynamic equations specify the electric and magnetic fields in terms of the distribution of charge and current throughout space, and two of these—expressing the laws of Coulomb and Ampère—do not involve the space-time transformations, so that their kinematical interpretation is not dependent on the principle of relativity. All four are linear in E and H, and therefore hold as well for the resultant of the simple fields due to a number of charged particles as for each field individually. The fifth equation gives the force on a charge moving through electric and magnetic fields. If the sources of moving elements constituting the charge are supposed to rotate, free magnetic charges are produced, and the four field equations assume a symmetrical form. The energy radiated due to the rotation is shewn to amount almost exactly to $1/32\ h\nu$, where ν is the frequency, and h is Planck's constant. This numerical coincidence suggests that quantum phenomena may be in some way connected with rotating electric fields, and that $h \equiv 64\pi e^2/3c$, when e is the electronic charge. G. W. DE T.

1186. *Construction of Magnetic Shell equivalent to Electric Current.* **A. A. Robb.** (Nature, 105. p. 199, April 15, 1920.)—The author points out that Maxwell's statement (Treatise, vol. 2, p. 142) that the construction of a surface with a linear end circuit as boundary is perfectly arbitrary, is incorrect. For, take a long narrow ribbon—of paper, say—and join the ends after turning one end through an angle π. The two edges will then form a single linear circuit, and the two surfaces of the ribbons will form one continuous band with a half turn in it. This Moebius surface, as the mathematician calls it, although bounded by the linear circuit, could not represent a simple magnetic shell, since, its opposed surfaces having become continuous, there can be no distinction between one as positive and the other as negative. Ampère's construction of elementary circuits on the surface equivalent to the linear circuit formed by the boundary similarly fails. The author suggests the formula:—Let O be a fixed point external to the circuit, and let a variable point P travel once completely round the circuit. The portion of a conical surface traced out by the radius vector OP which contains O and is bounded by the circuit, or any surface derived from it by continuous deformation, while the edge remains fixed, will constitute an equivalent magnetic shell.

G. W. DE T.

1187. *Value of Planck's Constant and Electron Charge.* **I. Langmuir.** (Frank. Inst., J. 189. pp. 603–605, May, 1920.)—The third and fifth of Birge's seven values for h [Abs. 123 (1920)] are derived respectively from the Bohr-Sommerfeld theory of atomic structure ["Atombau und Spectrallineen," Sommerfeld, Nov. 1919] and from the Lewis and Adams theory of ultimate rational units [Abs. 1091 (1914)], on the basis of Millikan's value $4 \cdot 774 \times 10^{-10}$ e.s. unit for e. The author derives from the same two sources combined a value $4 \cdot 745 \times 10^{-10}$ e.s. unit for e, and gives Birge's original values of h, and the values which would result from this value of e in the second and third columns of the accompanying table.

DETERMINATIONS OF *h*.

Method.	Dependence on e.	$e = 4 \cdot 774$.	$e = 4 \cdot 745$.
Stefan-Boltzmann Constant................	$e^{4/3}$	6·551	6·497
Wien Constant c_2	e	6·557	6·517
Bohr-Sommerfeld theory, Equations 2 and 3	$e^{5/3}$	6·548	6·481
Einstein's photoelectric equation	e	6·578	6·538
Quantum relation for X-rays	$e^{4/3}$	6·555	6·501
Lewis and Adams theory	e^2	6·560	6·481
Quantum relation for ionisation potentials..	e	6·579	6·539
	Average	6·555	6·507

The values of h calculated from $e = 4 \cdot 745$ are consistently smaller than those based on Millikan's value, but they agree among themselves within the probable experimental error. In any case the results do not warrant the conclusion that the Lewis and Adams or the Bohr-Sommerfeld theories are not rigorous. Unless one of these theories is incorrect or incomplete, however, the new values of e and h should have a much higher accuracy than any of the other experimental determinations given in the above table. Under these conditions it seems desirable that new determinations of the electron charge should be made, especially if new methods can be developed. G. W. DE T.

1188. *Radio-telegraphy and the Earth's Motion through the Ether.* **G. Sagnac.** (Comptes Rendus, 170. pp. 800–803, March 29, 1920. Rev. Gén. d'Él. 7. pp. 617–618, May 8, 1920.)—The author refers to the "zones of weak signals" observed by H. B. Jackson [Abs. 811 B (1903)] in non-synchronous radio-telegraphic transmission between moving ships, and claims that they are due to, and afford evidence of the existence of a dragging with it of the surrounding ether by the earth's orbital motion through it, giving rise to what he describes as "ether winds."

G. W. DE T.

DISCHARGE AND OSCILLATIONS.

1189. *Theory of Ionisation by Collision.* **P. O. Pedersen.** (Kgl. Danske Vidensk. Selskab. Math.-fys. Meddelelser, Kopenhagen, July 1, 1918. Jahrb. d. Drahtl. Tele. 15. pp. 289–299, April, 1920. Phil.

Mag. 40. pp. 129–137, June, 1920.)—A mathematical paper dealing with modifications of Townsend's theory. The latter gives a satisfactory and beautiful explanation of many questions, especially as regards the ionisation of gases, as shown by Kiebitz in research on directional wireless telegraphy, by the dependence of the ionisation current on the distance apart of the plates, and by the dependence of the sparking potential on pressure, etc.; but the value for the ionisation potential deduced from Townsend's theory is higher than that found directly by Franck and Hertz [Abs. 659 (1913)] and others. The modifications of Townsend's theory here given do not give complete agreement between the theoretical and experimentally found values for ionisation potentials, but tend in the right direction. For example, Townsend finds for air a value of about 20 volts (frequently still higher values), while Franck & Hertz find the ionisation potential to be about 10 volts. The modified theory now given yields a value of about 16 volts. A. W.

1190. *The Constitution of Kathode Rays in the Coolidge Tube.* **V. Polara.** (Accad. Lincei, Atti, 28. ii. pp. 73–78, 1919.)—A theoretical discussion of the nature of the kathode rays in the Coolidge tube. A. E. G.

1191. *Distribution of Ozone in the Direct-Current Corona.* **E. K. Rideal** and **J. Kunz.** (J. Phys. Chem. 24. pp. 379–392, May, 1920.)—The formation of ozone in a direct-current corona discharge was measured by the use of a thin brass tube of 2·54 cm. internal radius with a wire arranged longitudinally in the centre and supported by thin plates of quartz closing the ends of the tube. By means of direct-coupled dynamos, a difference of potential of 16,500 volts was applied between the wire and the surrounding tube. A slow stream of dry oxygen was passed through the tube and the distribution of ozone at varying distances from the centre was determined by two independent methods. (*a*) Samples of gas were withdrawn through a capillary tube introduced through the middle of the tube in a direction at right angles to the axis and arranged so that the tip could be adjusted to various positions in the annular space between the wire and the tube wall. The gas withdrawn was analysed by aspiration through a solution of potassium iodide. (*b*) The concentration of ozone was estimated optically by the passage at different positions of a parallel beam of ultra-violet light from a mercury-vapour lamp of constant intensity, the wave-length of the light being within the region $\lambda = 250$ to 350 $\mu\mu$. The intensity of the emergent beam, which was determined by the degree of absorption by the ozone, was measured by means of a photoelectric cell. When the central wire was connected to the positive pole, a rapid rise in the concentration of ozone was obtained with increasing distance from the wire, up to a distance of 7 mm., after which the ozone concentration remained practically constant at a value of 0·35 to 0·37% by volume. With the wire charged negatively, the concentration of ozone increased continuously from the centre to the walls of the tube where about 0·55% by volume was obtained. The results indicate that ozone is formed at the positive electrode rather than in the luminous part of the negative corona and in diffusing through the space between the electrodes undergoes a certain amount of decomposition. The concentration gradients obtained with a positive corona also support the assumption that the ozone molecules lose electrons and as a consequence the positive ozone gas-ions are repelled from the wire and thus give rise to the phenomenon of corona pressure.

The average yield of ozone obtained was 0·045 gm. and 0·025 gm. per coulomb with a negative corona and positive corona respectively.

The corona discharge is accompanied by the emission both of visible and ultra-violet light. [See Abs. 1286 (1912).] J. N. P.

1192. *The Action of Induction Coils.* **E. T. Jones.** (Röntgen Soc., J. 16. pp. 47–55; Disc., 55–58, April, 1920.)—This paper is chiefly a *résumé* of work on induction coils published previously by the author [see Abs. 334 and 1542 (1919)]. The question of optimum primary capacity with a giving coupling between primary and secondary coils is considered. A close agreement is found between theory and practice. For a certain value of the coupling there are two optimum values of the primary capacity, *i.e.*, two values for which the secondary peak potential is a maximum. With a certain coil the max. spark length was obtained with a coupling of 0·571. This is a result of the two secondary oscillations being in phase at the peak, *i.e.*, both reaching a maximum value simultaneously, and to the fact that the iron loss decreases with decrease in coupling.

A description is given of the author's electrostatic oscillograph for recording secondary wave-forms up to 200,000 volts. Oscillograms are given showing wave-forms for different ratios of the two oscillation frequencies. The iron loss, which causes a 25% reduction in peak potential, does not cause any pronounced distortion in wave-form.

The discharge through an X-ray tube is discussed and oscillograms with various forms of tube are reproduced.

The concluding paragraphs deal with points connected with the design of coils. N. W. M.

1193. *Vacuum Tubes with Double Grids.* **[Miss] M. A. Schirmann.** (Archiv. f. Elektrot. 8. pp. 441–446, March 18, 1920.)—A mathematical treatment of the behaviour of vacuum tubes with a central filament, two concentric grids and a concentric anode. The grids are of the squirrel-cage type, and possess the same number of parallel wires. The problem is considered from the electrostatic standpoint. A. W.

1194. *Plane Electromagnetic Waves in two Media.* **K. Uller.** (Jahrb. d. Drahtl. Tele. 15. pp. 123–152, Feb., 1920.)—Soon after the discovery of wireless telegraphy, it was supposed that the electromagnetic waves radiated by a vertical antenna were propagated along the earth's surface, just as electrical oscillations are guided by metallic wires. The author treated mathematically the case of waves propagated upon the sea, Zenneck [see Abs. 2095 (1907)] that of waves propagated upon the earth. In these studies it was assumed that the sending antenna was vertical and, therefore, the magnetic lines horizontal. In the present study the author examines the general case, supposing both the earth's surface and the waves to be plane.

The mathematical treatment does not allow of abstracting. From the expressions of electrical and magnetic intensities, in complex quantities, as functions of space and time, and from the fundamental equations of electrotechnics, four relations are obtained, the contemporary existence of which is possible only in two particular cases, which correspond to two different waves, called by the author waves of the first and second type. The wave of the first type is characterised by the fact that the magnetic field is parallel to the earth's surface; that of the second type is characterised by the reciprocal condition that electric lines are parallel to the earth's surface. Practically, this last wave is much less important than the first, as the permeabilities of the two media are the same, while the dielectric constants are widely different.

Details concerning the formation of waves of the first type are mathematically obtained and a discussion of practically observed variations in the intensity and direction of the waves concludes the article. E. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1195. *Thermoelectric Effect in Mercury.* — **Goulneau.** (Comptes Rendus, 170. pp. 1567–1570, June 28, 1920.)—The author gives an account of an experiment made to confirm the existence of the new thermoelectric effect described by Benedicks [Abs. 675 (1917)] when a homogeneous conductor is asymmetrically heated. Pure redistilled Hg was used in a glass tube bent into a rectangular form and constricted at one part. Heating at the constriction produced a fall of temperature estimated at 150 deg. over $\frac{1}{10}$ mm. This mercury circuit was suspended between the poles of an electromagnet, and with a field of 2000 gauss a deflection of 500 mm. was obtained on a scale distant 1500 mm. The disturbing effect of convection currents was only of the order 1 or 2 mm scale deflection. L. L.

1196. *Measurement of Photoelectric Currents.* **E. Meyer, H. Rosenberg,** and **F. Tank.** (Archives des Sciences, 2. pp. 260–262, May–June, 1920. Paper read before the Soc. Suisse de Physique.)—The intensity of photoelectric currents may be magnified by means of valves. In this connection Pike [Abs. 627 (1919)] has concluded that a constant amplification is not in general obtained, but that the amplification increases when the intensity of the photoelectric current decreases. Though this is probably true within the limits observed by Pike, yet the conclusion that the same holds good for very feeble photoelectric currents does not seem to be justified. Experiments made with an arrangement similar to that of Pike have shown that, for currents of the order of magnitude 4×10^{-12} amp. to 130×10^{-12} amp., there is, within the errors of observation, rigorous proportionality between the unamplified and amplified currents. The amplification ratio has a constant value for these small currents, and this value depends on the filament current and anode potential of the valve. Values for this ratio were obtained between 5000 and 15,000. In later experiments Rosenberg obtained amplification ratios up to 125,000, the proportionality between the photoelectric and amplified currents always being rigorous. It is proposed to utilise the arrangement for stellar photometry. A. W.

1197. *Reproduction of Speech by Galena.* **[Mlle.] P. Collet.** (Comptes Rendus, 170. pp. 1378–1380, June 7, 1920.)—Brazier and Dongier [Abs. 292 (1914)] found that passing an alternating current across the contact of a metal point and a crystal of galena resulted in a sound being given out when the current was sufficiently strong. Using continuous waves, Collet has found that the galena contact is responsive to variations of such waves, as, for example, the periodical interruption by means of an electrically maintained fork. With a platinum point connected to the reproducing diaphragm of a phonograph, the sound given out is, under the above conditions, of the same pitch as that of the fork. If a microphone is included in the continuous-wave circuit with which the crystal contact is connected, words spoken into the microphone are reproduced by the crystal contact loudly and clearly. For these experiments the leads to the contact are several yards long, so that the reproduction may take place in another room. The phenomenon appears to be of thermal origin. The action is much more pronounced with points of the crystal which are sensitive receivers for electric waves. A. W.

1198. *Rectification by Galena.* [**Mlle.**] **P. Collet.** (Comptes Rendus, 170. pp. 1489–1491, June 21, 1920.)—Experiments are described which show that galena exhibits a double rectification. With feeble waves incident on the crystal contact, using a sensitive point, it is found that the magnitude of the rectified current varies very considerably with the point chosen. But when the energy of the waves is increased beyond a certain value, all specimens of galena behave alike, and the rectification is in the opposite sense to that found with weak waves using a sensitive crystal. If a sensitive crystal is employed and the energy progressively increased, the current across the contact is at first in one direction, is zero for a certain energy value, and beyond this is in the opposite direction. The latter direction is the same as for any non-sensitive crystal for large energy values. A. W.

1199. *Rectification by Galena.* **C. Florisson.** (Comptes Rendus, 171. pp. 106–108, July 12, 1920. Rév. Gén. d'Él. 8. pp. 175–176, Aug. 7, 1920.)—The author has examined the effect of various heat treatments on the rectifying properties of specimens of galena. Heat applied in an atmosphere of nitrogen or ordinary air to non-sensitive specimens produced little effect. Pure and dry SO_4 at a high temperature produced sensibility, but the results were very irregular; but using sulphur vapour in a current of nitrogen excellent results were obtained, the whole crystal surface being sensitised: the sensitivity was of the same order as that found with naturally sensitive specimens. A certain minimum temperature is necessary to produce the best results, this minimum varying with different specimens. The appearance of the crystals is not altered. The effect is due to the formation of a surface layer containing probably more sulphur than lead sulphide, the two forming a sort of solid solution.

A. W.

1200. *Dilatation at the Point of Contact of two Solids, due to the Joule-Effect.* **J. Fallou.** (Comptes Rendus, 170. pp. 1308–1310, May 31, 1920.)—Brazier and Dongier [Abs. 292 (1914)] have shown that a point crystal contact subjected to an alternating e.m.f. is capable of emitting a sound. The author has studied the very small displacements of the point of contact by means of a simple apparatus consisting essentially of a long light lever to one end of which the crystal was attached, and whose other end was observed by means of a microscope provided with a micrometer eyepiece. A 100-fold magnification was obtained in this way. After obtaining current–e.m.f., dilatation–e.m.f., and dilatation–

power curves, it was found that the dilatation is very approximately proportional to the power lost, and that it is consequently due to the Joule-effect, but the ratio of the dilatation to the power lost (coefficient of dilatation) is very different according as the current passes in one direction or the other. The magnitude of the dilatation varies considerably with metals and crystals in contact, but the difference between the coefficients of dilatation on changing the direction of the current is greater the greater the rectifying power of the combination used. The coefficient of dilatation is greater the greater the resistance of the contact. There is no proportionality between the coefficient and the coefficients of linear dilatation of the metals at the junction, and the Thomson-effect explains neither the magnitude nor sign of this phenomenon. A. W.

1201. *An Inductionless High Resistance.* **N. W. McLachlan.** (Radio Rev. 1. pp. 429–431, June, 1920.)—This paper describes a form of inductionless high resistance consisting of a U-tube containing a solution of cadmium iodide in amyl alcohol. Electrodes of pure cadmium are situated at the upper extremities of the tube. The values of the resistances constructed varied from 0·1 to 0·3 megohm. Methods of constructing variable resistances of this magnitude are suggested. The method of testing for inductive effects was an adaptation of the Wien bridge, the resistance being used as a shunt to an air condenser and the equivalent series resistance found experimentally. A close agreement was noted between the calculated and experimental values of the equivalent series resistance up to 80,000 cycles per sec., this being the highest frequency attained. The above form of resistance was specially designed for use with a magneto to simulate the leakage of a sparking plug in a petrol engine.

Since the solution is unpolarisable and free from inductive effects, its h.f. resistance can be measured by direct-current methods. For magneto work this can be accomplished with a megger. N. W. M.

1202. *Characteristic Curve and Consumption of Power in the Interrupter functioning in the Primary Circuit of an Induction Coil.* **G. C. Trabacchi.** (Accad. Lincei, Atti, 28. ii. pp. 354–358, Nov. 30, 1919.)—The conclusion arrived at is that the wattmeter can be employed to measure the power expended in an interrupter functioning in the primary of an induction coil without fear that the rapid variability of the elements in action may cause serious errors. A. E. G.

1203. *Measurement of Frequency of Weak Currents of Audible Frequency.* **K. Wolff.** (Jahrb. d. Drahtl. Tele. 15. pp. 321–326, April, 1920.)—A description is given of an apparatus for the accurate determination of the frequency of weak currents giving audible notes. The principle of the arrangement is the same as that given by A. Campbell [Abs. 1842 (1908)] and Larsen [Abs. 1044B (1910)]. The frequency is determined as a function of the degree of coupling between the two inductance coils employed. A photograph and wiring diagram are given. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

1204. *Internal Friction of Cobalt in a Variable Magnetic Field.* **E. Drago.** (Accad. Lincei, Atti, 28. ii. pp. 351–354, Nov. 30, and pp. 434–438, Dec. 7, 1919.)—The internal friction of a cobalt wire always increases in a variable magnetic field, the contrary of that which takes place in the case of wires of iron and nickel. Under the experimental conditions described it appears that the greatest increases are attained with the intermittent magnetisation produced by the oscillatory discharges set up at the beginning and end of each simple oscillation of the wire. Corresponding to such increase of internal friction there is produced a temporary deformation of torsion of the cobalt wire under the action of the oscillatory discharge. A. E. G.

1205. *Magnetic Variation of Resistance of Bismuth.* **O. M. Corbino.** (Accad. Lincei, Atti, 28. i. pp. 49–57, Jan. 5, 1920.)—A treatment of the theory of the variations of the resistance and of the Hall-effect with increase of magnetic field in the case of metals such as bismuth. [See Abs. 1135 (1915) and 1557 (1919).] J. W. T. W.

1206. *Relation between Hall-Effect and Corbino-Effect for Bismuth.* **G. C. Trabacchi.** (Accad. Lincei, Atti, 28. ii. pp. 276–281, Nov. 2, 1919.)—Describes experiments upon the effect of temperature on the Hall-effect and Corbino-effect [see preceding Abs.] in the case of bismuth, and shows that E/Rc is a constant, where E is a characteristic of the metal, R the coefficient of the Hall-effect, and c the conductivity. J. W. T. W.

1207. *Analysis of Three Galvanomagnetic Effects. Confirmation of the New Effect.* **A. Sellerio.** (Comptes Rendus, 170. pp. 1570–1573, June 28, 1920.)—Explains mathematically how the observation of the Hall-effect as usually carried out is made up of three components: (1) the ordinary transverse Hall-effect, (2) the axial effect described by La Rosa and Sellerio, (3) the resistance change. The relative magnitudes of these components for varying orientation are discussed. L. L.

1208. *Galvanomagnetic Effect Parallel to the Lines of Force and Normal to the Current.* **La Rosa** and **A. Sellerio.** (Comptes Rendus, 170. pp. 1447–1450, June 14, 1920.)—In a previous paper La Rosa [Abs. 145 (1920)] has advanced the hypothesis that the number of free electrons per cm.^{3} for a metal conveying current in a magnetic field is proportional to the field strength, and upon this basis established a relation between the change of electrical resistance in the magnetic field and the thermoelectric power of the metal. In seeking to explain the Hall phenomenon from the same standpoint, the authors have been led to the conclusion that when a plate is arranged in the magnetic field for observation of the Hall phenomenon a current should also exist in the direction of the lines of force and normal to the primary current. Experiments made with discs of Bi and Te have established the existence of this effect. The deflections obtained on reversing the field and primary current show that in addition to the ordinary transverse Hall-effect, there are present an axial effect and a small resistance effect. L. L.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1209. *Transformers* v. *Induction Coils. The Efficiency of Transformers for X-Ray Purposes.* **R. Morton.** (Röntgen Soc., J. 16. pp. 93–94, July, 1920. Abstract of paper read before joint meeting of the I.E.E., the Royal Society of Medicine, and the Röntgen Soc., Feb., 1920. Electrician, 84. p. 289, March 12, 1920. Abstract.).—With the aid of an oscilloscope and a rotating mirror the coil shows us an alternating current quite unsymmetrical both in form and duration; the transformer, a series of rectified sine curves. The first is the more efficient for X-ray work, up to the limits of its capacity. It gives more penetration and more actinism for a given current, greater steadiness, less heating, and a longer useful life for the X-ray tube. A further point in favour of the coil current is that it will keep a tube working smoothly on a lower reading of the milliammeter. Every tube has a certain amount of inertia and requires a higher voltage to start it than to maintain it in action; the sudden rise at the moment of "break" readily overcomes this inertia. Penetration is dependent on electron velocity within the tube, which in turn is dependent on the impressed voltage. The ideal current is one consisting of extremely high-voltage impulses, of very brief duration as judged by ordinary standards, yet sufficiently sustained to have an appreciable time factor. If the voltage of the initial impulse be sufficiently high and sustained, one such impulse will be enough for any ordinary purpose in radiography. In the case of the coil the initial current is high, but its duration is extremely short. This is partly due to the self-induction of the secondary, cutting off this rush of current almost simultaneously with its birth. It is also due in no small degree to something inherent in the X-ray tube itself. Notwithstanding its brief duration it is this impulse that makes the coil current so efficient up to the limit of its capacity. It is the absence of any such high-voltage impulse that keeps the efficiency of the transformer current so low. For the same current through the same tube, the top of the transformer curve extends little more than half-way to the highest point of that of the coil. Of the total radiation from a tube energised by a coil, probably no more than 20% consists of useful rays; when energised by a transformer, the proportion is probably less than 10%. It is suggested that the initial impulse is the only part of the cycle that matters in X-ray work, and attention should be concentrated with a view to increasing its height, or to prolonging its duration. It would appear that the future of radiography is bound up more or less inseparably with the "single flash" system.

A. E. G.

1210. *Radiographic Phenomena. Quantitative Laws. The Nomogram.* **G. Mazérès.** (Archives d'Él. Médicale, 28. pp. 65–84, March, and pp. 107–117, April, 1920.)—The theory of the subject is first considered, then practical rules are indicated and a nomogram for simplifying the work is described. The theory is discussed, in the first paper, under the following heads: Successive stages of the phenomena; the transformation of energy. The first stage includes electric energy; electronic energy (*a*) as in ordinary bulbs, (*b*) as in Coolidge tubes; radiant energy. The second stage includes the distance focus-object factor-law of square of distances; the object factor; transmission and absorption of the radiation; the sensitive plate factor; photochemical energy. In the second paper the laws of radiographic exposure are dealt with along the following lines: *Résumé* of the phenomena; the constituents of the process (*a*) the electric energy of the secondary with its two factors (difference of potential or spark-length and quantity of electricity), (*b*) the transformer bulb with its two factors (hardness of rays and quantity of pulsations); (*c*) the space traversed by the pulsations with the two factors: distance focus-plate and region radiographed. The other points considered are: General formula; homogeneity of the formula; practical formulæ; the nomogram.

A. E. G

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CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1211. *Search for an Alkali Element of Higher Atomic Weight than Cæsium.* **L. M. Dennis** and **R. W. G. Wyckoff.** (Am. Chem. Soc., J. 42. pp. 985–990, May, 1920.)—The alkalies from a large quantity of pollucite were subjected to fractionation in various different ways, the fractions in which the higher analogue of cæsium, eka-cæsium, might be expected to be concentrated being examined by means of the arc spectra of the solid material in the red, the visible and the ultra-violet portions of the spectrum. In no case were indications of the existence of eka-cæsium observed. T. H. P.

1212. *Activity of Gases in an Extreme State of Division.* **C. Zenghelis.** (Comptes Rendus, 170. pp. 883–885, April 12, 1920.)—Certain elements when generated directly in the presence of bodies with which they can react are much more active even at the ordinary temperature than under the usual conditions. This increased activity is generally attributed to the greater amount of free energy of the atomic state. The elements which exhibit this so-called nascent state are all gases; *e.g.*, hydrogen, oxygen. The fact that these cases of activity are only exhibited when the gases are evolved in a liquid medium as extremely small bubbles, or when they are occluded in metals in which they are very finely subdivided, has led the present author to investigate whether the activity is due to the extreme nature of the state of division. A number of experiments are described in which the author has caused the various gases to pass through filter paper, parchment paper for dialysis, etc., thereby effecting an extremely fine condition of subdivision by mechanical means. Under the pressures applied, the gas did not pass through the pores of the paper, but within the pores the dissolved bodies underwent reaction. Mercuric chloride heated to 90° C. was found to be reduced to mercurous chloride in appreciable amount. Within an hour, also, 10% potassium chlorate gave potassium chloride at 80–85° C. In the cold, 10% potassium nitrate gave the reaction for nitrite in half an hour. The most interesting reduction, however, was that of water saturated with CO_2, which gave methyl alcohol, trioxymethylene, aldehyde, and a sugar. The same products were given with a solution of calcium bicarbonate. At 65° the reduction proceeds more rapidly, giving the same products but more especially trioxymethylene. When oxygen was used instead of hydrogen, potassium iodide was oxidised to iodine, ammonia to nitrous acid, and methyl alcohol to formaldehyde. Nitrogen itself combines with hydrogen, when a mixture $(3\,H + N)$ is used, and after half an hour the Nessler ammonia test was given. These results show that gases greatly increase in activity when mechanically subdivided. In the case of gaseous absorption by metals, whose pores are smaller than those of collodion and other materials used for the ultra-filtration of colloids, a surface should be developed at least half a million times greater than by bubbles of 4 mm. diam. Some experiments with carbon monoxide tell heavily against the nascent theory—namely: occluded by platinum or forced through dialysis paper, energetic reductions ensue such as those of iodic acid, sodium molybdate and potassium nitrate. Carbon monoxide being a chemical compound, the atomic explanation is no longer applicable. The extreme state of division of a gas is therefore proposed as an explanation of the activity usually attributed to a free atomic condition. H. H. Ho.

1213. *Decarburisation of Steel with Hydrogen.* **E. D. Campbell.** (Iron and Steel Inst., J. 100. pp. 407–414; Corres., p. 415, 1919.)—Experiments carried out on the behaviour of carbon and alloy steels when heated in hydrogen at various temperatures showed the max. decarburising effect to occur between 950° and 1000° C. Examination of the evolved gases was made and the resulting samples were subjected to chemical analysis and specific resistance determinations. Plain carbon steels were almost completely decarburised after four days' treatment, showing that the pure carbides are unstable and almost completely dissociated in solid solution. Silicon appears to be capable of partially replacing the carbon in the carbide molecule, thus modifying the products of dissociation. The double carbides of iron and manganese are much more stable than the pure carbide of iron. About one-third of the sulphur is removed except in the case of high-manganese steels. Decarburisation lowers the resistivity of pure carbon steels, but in steels containing chromium, tungsten or molybdenum which form complex carbides, decarburisation increases the resistivity by setting free these elements, which then pass into solid solution in the alpha iron. Nickel steels behave like plain carbon steels, since Ni has a lower affinity for carbon than iron has and therefore associates with the solvent rather than with the carbides. F. C. A. H. L.

1214. *The Growth of Grey Cast Iron.* **M. Ôkôchi** and **N. Satô.** (Tōkyō Univ. Coll. of Eng., J. 10. pp. 53–71, Feb., 1920.)—It is commonly understood that grey cast iron, when subjected to repeated heatings, increases in volume, due to the internal oxidation of the various constituents of the material by the penetration of oxidising gases. This paper gives the results of an extended research which shows that the oxidation of the constituents plays no important rôle in the problem of growth. Dilatation–temperature curves of grey iron, in the heating and cooling courses, are parallel to one another as far as the transformation temperature, except in the first heating. Permanent growth is never produced at temperatures lower than that of transformation, except in the first heating, although oxidation takes place with increase of weight. Rapid expansion from about 650° to near the transformation point in the first heating is caused by the separation of free carbon from cementite. This separated carbon easily oxidises and escapes as carbon oxide. If the specimen is kept for some time at a constant temperature higher than the transformation temperature, it gradually elongates to a certain limit, after which no growth is observed unless it is heated to a higher temperature or cooled below the transformation temperature and again heated; cooling to room temperature is not necessary. There is a small amount of growth produced by heating in vacuum and the expansion at the A_r transformation is rather greater than that which would occur by heating in the air. The same growth as in the case of heating in air is obtained when heating in hydrogen. In the magnetisation–temperature curve of the original casting, the magnetic transformation of cementite at 210° C. is very clearly observed, and by heating higher, the separation of free carbon near 650° C.; almost all the cementite in cast iron containing a certain amount of silicon is completely decomposed during the heating up to the temperature of transformation. By microscopic study it is observed that the space occupied by the flakes of graphite is exceedingly enlarged by repeated heatings.

There are two periods of growth in grey iron. One occurs at temperatures higher than that of the transformation, due to the pressure of occluded gases and the falling of the limit of elasticity of cast iron at high temperatures; the other period of growth occurs during the transformation and is also due to pressure of gases, in this case resisting the contraction due to the change of α into γ by heat.

The fact that there is no growth in the case of white iron, even after repeated heatings, is due to the absence of free carbon; therefore no room is allowed for the expansion of occluded gases and no passage along the flakes of graphite for the penetration of gases. C. O. B.

1215. *Heat Treatment of Beta Brass.* **H. M. Brayton.** (Chem. and Met. Eng. 22. pp. 211–217, Feb. 4, 1920.)—Gives the results of research work on the relation between various physical properties of beta brass, as the annealing temperature is varied. Two alloys were used for the work, a sample containing Cu 56·17, Zn 41·24, Pb 2·53, Sn 0·06% showed that, with rising temperature of quenching, the tensile strength curve shows a tendency to rise, whereas with rising temperature of annealing the tendency is downward. By means of the two charts, almost any strength within the range of the material may be obtained. The ductility curves are very irregular, but in general the ductility of the annealed material is higher than expected, and the quenched material shows low ductility at the high temperatures. Several of the specimens broke in the punch marks or threads during testing, and this trouble seemed most evident in the slowly cooled specimens. The hardness of this alloy does not seem to be affected by heat treatment. In the case of the second alloy containing Cu 60·58, Zn 38·67, Pb nil, Sn 0·75% the reduction of area falls off when quenched at temperatures above 600°, but this property is well maintained by slow cooling. Even at 800° the ductility is not appreciably diminished after slow cooling. Up to a temperature of 550° the ductility is nearly as high in the quenched specimens as in those slowly cooled, which indicates that no appreciable change has taken place in the structure due to heating up to this temperature. This is probably due to the fact that the change from the alpha plus gamma which is present at ordinary temperatures to alpha plus beta takes place at a low velocity, and if the alloys were heated for a long period at 500° instead of for the two hours, used in this research, quenching would produce a smaller ductility, as more of the structure would be transformed. C. O. B.

1216. *Graphitisation of White Cast-Iron.* **R. S. Archer.** (Am. Inst. Mining Eng., Bull. No. 158. [8 pp.], Feb., 1920.)—The presence of 1·0% Si raises the *Ac*1 point probably to 765° C. and the *Ar*1 point to 735° C. At 690° C. the complete graphitisation of the carbide occurs in about 190 hours, while at 735.° C. (*i.e.*, below the *Ac*1 point of the iron used with 1·05% Si, 0·35 Mn, 0·035% S, and 2·9% C) only 0·05% of combined carbon exists after 150 hours. A specimen which had been completely graphitised showed again, on being reheated to 771° C., the presence of pearlite. It would therefore appear that graphitisation can be initiated and completed in white cast-iron at temperatures below the A1 point and that it cannot be completed at temperatures above A1. At temperatures above A1 the combined carbon tends to attain a constant value for the iron of the above composition of 0·67% carbon at 785° C., and of 0·83% carbon at 835° C. For practical purposes the graphite solubility curve can be considered as coinciding with that of cementite, due allowance for the Si present being made.

Slow cooling through $Ar1$ after treatment above $Ac1$ increases the graphite present. With the possible exception of the initial stages, graphitisation takes place directly from the solid solution. [See Abs. 1337 and 1439 (1919).] F. C. T.

1217. *Further Studies on a Lead Standard Cell.* **M. G. Mellon** and **W. E. Henderson.** (Am. Chem. Soc., J. 42. pp. 676–689, April, 1920.)—In 1916, Hulett and his co-workers stated that, in addition to mercury, zinc and cadmium are the only two metals which fulfil the conditions necessary for the construction of a standard cell, and that it is improbable that the other metals will be found of service in such cells [see Abs. 409 (1916)]. However, early in 1917 Henderson and Stegeman [Abs. 323 (1918)] constructed a cell according to the type $PbHg/PbSO_4//Na_2SO_4, 10H_2O//H_2SO_4/Hg$, in which PbHg represents a saturated amalgam, and the other formulæ represent saturated aqueous solutions of the salts at 25°. This cell has now been found to give the same e.m.f. (0·96466 volt at 25°) as new cells of the same construction, and to have a constant value. Similar saturated cells have been studied, using, in addition to sodium sulphate, the well-defined soluble sulphates of Ni, Co, Zn, Mn, K, Li, Mg, Cd, and Cu. Observations on these cells confirm, in general, the work of Henderson and Stegeman on the constancy and reproducibility of cells containing sodium sulphate. Saturated cells containing the sulphates of Ni, Co, Zn, or Mn are substantially as reproducible and as constant as those containing sodium sulphate. This constancy is attained within 4–5 days after preparation, and, during the time over which they have been studied (21–90 days), these cells appear to possess the characteristics necessary for a standard cell. The e.m.f. of the constant cell seems to be nearly independent of the soluble sulphate used. The values for cells containing sodium sulphate or nickel sulphate practically coincide, whilst those for cells containing the sulphates of Co, Zn, or Mn are very close together, but slightly higher than the first two (0·96478 volt as against 0·96466 volt). Saturated cells containing the sulphates of Li, Mg, or Cd are neither reproducible nor constant, although their e.m.f. is of approximately the same magnitude as that of the constant cells. Saturated cells containing potassium sulphate are also neither constant nor reproducible; the mercurous sulphate in them is distinctly hydrolysed, and their e.m.f. is markedly higher (1·03 volts) than that of other cells. Saturated cells containing copper sulphate agree well among themselves (0·3489 volt), but are not constant. Their low e.m.f. indicates that secondary actions have taken place, probably giving the cell:

$$CuHg/CuSO_4, 5H_2O/Hg_2SO_4/Hg.$$

Unsaturated cells, made from solutions which were saturated at 20°, containing the sulphates of Na, Zn, Ni, Co, and Mn, give results showing that they are as reproducible as the corresponding saturated cells, their e.m.f. being practically the same. They are, however, constant for a time only, and then begin to exhibit a decreasing e.m.f. The unsatisfactory nature of the cells containing the sulphates of Li, Mg, and Cd is probably not caused by the coexistence in the cell of the anhydrous sulphate and a hydrate or of different hydrates, the unsaturated cells behaving similarly to the saturated ones. Analytically, microscopically, and thermometrically, there was no evidence of the formation of double salts. Only with potassium was evidence found of double-salt formation, namely, potassium lead sulphate. T. S. P.

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